EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILISERS ON YIELD AND QUALITY OF MULBERRY AND COCOONS

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Affectionately Dedicated to
My Beloved

Father	**Thimmappa (Late)**
Mother	**Venkatamma**

DEPARTMENT OF CHEMISTRY AND SOILS
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BANGALORE

CERTIFICATE

This is to certify that the thesis entitled "EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON YIELD AND QUALITY OF MULBERRY AND COCOONS" submitted in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE (AGRICULTURE) in SOIL SCIENCE, to the University of Agricultural Sciences, Bangalore, is a record of research work carried out by Mr. C.T. SUBBARAYAPPA, under my guidance and supervision and that no part of the thesis has been submitted for the award of any other degree, diploma, associateship, fellowship or other similar titles.

Bangalore,
March , 1988

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INTRODUCTION

I. INTRODUCTION

Progressive increase in population has escalated the requirements of food,fiber and industrial raw materials which have to be produced on farm lands.

Mulberry constitutes only the satisfactory food of silkworms. It is a very hardy plant belongs to the genus morus, under the family Moraceae. The total area under mulberry in India is about 2 lakh hectare of which about 87 thousand hectare under rainfed condition. Karnataka accounts for about 60 per cent of the total land under rainfed and the rest under irrigated condition. The total silkworm cocoon production during 1984-85 has been estimated to be 41,600 metric tonnes. Mulberry leaf protein is the chief source for the silkworm to biosynthesize the silk which is made up of two proteins.

The improvement in the yield and quality of mulberry can be accomplished through application of fertilizers. Literature elsewhere suggests that mulberry plant responds greatly to nitrogen applications and the nutritive quality of foliage will be improved by supplying phosphatic and potassic fertilizers along with nitrogen (Basavanna et al., 1974 and Kasiviswanathan et al., 1979).

Since mulberry can be grown on a variety of soils under different agro-climatic conditions, there is need to workout its fertilizers requirements in order to enhance its yield and nutritive quality. A field trial was laid out at the main research station, University of Agricultural Sciences, Hebbal, Bangalore, to study the effect of different sources of nitrogenous fertilizers on yield and quality of mulberry and silkworm cocoon productivity with the following objectives.

1. To study the effect of different sources of nitrogenous fertilizers with and without lime on the yield and quality of mulberry leaves.

2. To ascertain the impact of feeding such mulberry leaves on the production and quality of cocoons.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

This chapter touches a brief resume of research studies related to the use of different sources of nitrogenous fertilizers and related aspects in mulberry and silkworm nutrition, growth, quality and production of mulberry. For any increase in leaf yield of mulberry per unit area of land, the native soil fertility alone cannot be relied upon and recourse has to be made to application of fertilizers and manures.

Managing the crop through better nutrition for good harvest of quality leaves is of immense importance in mulberry cultivation.

As the leaves are grown only for feeding of silkworm. it would be useful if management practices for increased production of mulberry are studied with reference to the yield and quality of cocoons. Literature on the yield and quality of mulberry and cocoons by the application of fertilizers has been reviewed under following headings.

2.1 Effect of different sources of nitrogenous fertilizers on yield and quality of mulberry and other field crops

2.1.1 Yield

Murthy (1953) reported that due to application ammonium nitrate subsequently with calcium ammonium nitrate gave highest leaf yie of mulberry compared to ammonium sulphate.

Pain (1965) reviewed that highest leaf yield was obtained in the NPK combination. Comparitively poorer yields obtained in the treatment of 'No Nitrogen', and with NPK the increase in leaf yield was as much as 108.30 per cent over the control.

Iruthayaraj and Rajarathnam (1965) found that calcium ammonium nitrate was as efficient as ammonium sulphate and urea in increasing yield of Co-7 ragi.

Kasiviswanathan and Sitaram Iyengar (1966) showed that, nitrogen fertilization significantly increased the leaf and stalk yield of mulberry. Fresh and dry matter production also increased due to nitrogen application.

Basavanna <u>et al</u>.(1967) noticed that a higher population of mulberry require a higher level of nitrogen to maintain better vegetative growth of mulberry.

Kasiviswanathan and Sitaram Iyengar (1968) reported that there was no significant increase in yield among different forms of nitrogen. But calcium ammonium nitrate and urea gave superior performance than the two other sources.

Kasiviswanathan and Sitaram Iyengar (1969) stated that the application of 50 kg N per hectare under rainfed condition significantly increased the yield of mulberry over no nitrogen.

Further the authors also stated that the increased yield was due to efficient moisture utilization as influenced by the increased availability of nitrogen.

Application of nitrogen significantly increased the yield (Kasiviswanathan and Sitaram Iyengar, 1969) and the pooled estimate showed that there was a progressive and significant increase in yield for every additional dose of nitrogen upto 100 kg N per hectare.

Kasiviswanathan and Sitrarm Iyengar (1970) indicated that the importance of NPK in increasing the yield of mulberry leaf needs no emphasis. The influence of nutrients on the lea yield of mulberry crop in general is influenced by nitrogen than other nutrients.

Krishnaswami et al.(1970) reported that three times pruning at the manurial dose of 150 lbs N, and 50 lbs P_2O_5 per acre, produced more leaf yield.

Sengupta et al.(1972) working on seasonal and total leaf yield of mulberry under different doses of nitrogen in West Bengal found that application of nitrogen beyond 300 kg N per hectare indicated a fairly consistant increase of about 5.6 per cent in mean leaf yield for each additional 100 kg N per hectare applied.

Ray et al. (1973) reported that highest leaf yield of mulberry recorded with 336 kg N, 180 kg P_2O_5, and 112 kg K_2O, per hectare and FYM 22,000 kg per hectare. It is quite apparent that nitrogen plays the most important role in increasing the yield of leaf the role of P_2O_5 and K_2O does not appear to be so important.

Kasiviswanathan et al. (1975) revealed that there was a progressive and significant increase in total mulberry leaf yield up to 600 kg N per hectare.

Vimala Purushothaman (1978) studied between N sources and levels on some Malaysian leaf vegetables, calcium ammonium nitrate gave consistently higher yields than the ammonium chloride.

The application of NPK fertilizer to soils increased the fresh weight of mulberry leaves to the extent of 21 per cent over no fertilization. Further supplimentation of foliar nitrogen caused further increase in the yield to an extent of 40 per cent. The relative efficiency of different sources of nitrogen fertilizer applied as foliar at 0.5 per cent concentration is in the order of urea $>$ calcium ammonium nitrate $>$ ammonium nitrate $>$ ammonium sulphate (Mancha Shetty, 1979). Further, the author also revealed that the NPK application caused rapid increase in leaf area index. However foliar feeding of different sources of nitrogen except urea did not enhance the leaf area index.

Anon. (1986) revealed that calcium ammonium nitrate treated plots yielded significantly higher quantity of mulberry leaves than urea treated one, and both were better than control.

Fotedar and Chakraborthy (1986) indicated that the application of nitrogen, 50 per cent through leaves and 50 per cent through soil found to be more effective on the leaf yield of mulberry than exclusively through soil. Further the foliar application of nitrogen (100%) gave an increase of 46.6 per cent in the leaf yield over control while as 50 per cent foliar and 50 per cent soil application gave an increase of 38.7 per cent over control.

2.1.2 Chemical composition and proximate constituents of mulberry leaves

Prince (1954) reported that an increase in the number of top dressing of N for annual application increased the yield and the N, P and K content of grasses.

Grunes and Krantz (1958) observed that top dressing of N in the spring 2 to 3 weeks before oats were ploughed-in at boot stage, increased the N, P and K concentration.

Chander (1959) stated that Napier grass, guineagrass and paragrass responded to annual application of nitrogen upto 800 pounds per acre. The protein content and protein yield was increased up to the highest nitrogen level.

Grunes (1959) reported that addition of nitrogen fertilizers has marked effects on the absorption of soil and fertilizer phosphorus by plants. The addition of ammonical nitrogen fertilizers rather than nitrate nitrogen fertilizers increased phosphorus adsorption. Nitrogen salts may influence adsorption of phosphorus by plants altering the phosphrous solubility in soil.

Gopalaswami and Raj (1972) indicated that nitrogen application increased the potassium content and uptake of plant due to increase in root system and higher absorption capacity of roots.

Mathis et al. (1973) reported that nitrogen content of forage increased due to increased application of nitrogen and it was greater in second harvest than first.

Westfall et al. (1973) reported that higher nitrogen application increased the phosphorus uptake due to increase in root growth and higher absorption capacity of roots.

Anon. (1974) indicated that the treatment of soil application 50 kg N per hectare and foliar application of 50 kg N per hectare produced highest crude protein over the other treatments in the mulberry.

Basavanna et al.(1974) found that application of 900 kg N per hectare increased the crude protein content by 3.89 per cent. Author also stated that Kanva variety spaced at 45 x 10 cm with a nitrogen level of 300 kg per hectare was considerably increased the crude protein.

Anon. (1976) reported that application of high dose of nitrogen in combination with P and K increased the crude protein content from 15 to 73 per cent.

According to Bommegowda (1978) increase in nitrogen level did not bring about any significant change in potassium content, but its up take was significantly increased due to increase in dry matter yield of Java citronella.

Manchashetty (1979) revealed that a considerable variations in NPK content of leaf tissues as a result of fertilizer application. Nitrogen accumulation was found more in the leaf tissue followed by potassium. Maximum accumulation of NPK in leaf tissue was observed with fertilizer NPK treatments followed by spraying of urea at 0.5 per cent. As regards to the maximise composition of mulberry leaves is considered, crude protein contents was found considerably enhanced by application of basel NPK as well as foliar application of nitrogen. Among the sources of foliar spray tried, the relative performance was in the order of urea calcium ammonium nitrate $(NH_4)_2SO_4$. The increase in the total mineral matter was also observed by the application NPK followed by foliar spray.

2.2 Effect of different sources of nitrogenous fertilizers on yield and quality of cocoons

Narayana et al. (1966) indicated that feeding of silkworm with leaves grown under nitrogen fertilization showed that nitrogen fertilization significantly increased the full grown larval weight. Cocoon weight and shell weight. Further it was also noticed that even the application on 200 kg N per hectare was not harmful to any of the cocoon characters.

Sidhu et al. (1969) reported that the leaves grown under nitrogen, phosphorus and potash fertilization improved the larval growth, cocoon yield and other cocoon characters. The effect of potassium application was more pronounced compared to phosphate application.

Kasiviswanathan and his associates (1970) observed that the application of N favoured slightly higher cocoon yield, silk percentage and filament length while, mature larval weight, shell weight and single cocoon weight and denier did not show any increasing trend.

Krishnaswami et al. (1971) noted that the application of nitrogen even at the rate of 900 kgs per hectare did not cause any harmful effect in cocoon yield on the other hand, there were indications of improvement of the cocoon crop yields and cocoon characters like shell weight, shell percentage, and filament length.

Sengupta et al. (1973) reported that levels of fertilization indicated a definite effect on the improvement of cocoon characters but between the range of 0 and 300 kg of added nitrogen per hectare only, beyond which the effect of nitrogen has been almost exclusively on the higher productivity of leaf and resultant higher cocoon productivity rather than on any significant improvement on cocoon quality.

Manchashetty (1979) concluded that the silkworms fed with mulberry leaves treated with NPK fertilizer produced less number cocoons per litre with increase in weight indicating the higher production of silk fibre. This was further enhanced by foliar application with urea and calcium ammonium nitrate. The author also noticed the impact of fertilizer application to mulberry plants followed by foliar spray, was also improved the quality of silk. Silkworms fed with mulberry leaves treated with urea produced silk with longer fiberes and renditta.

Venugopal Pillai et al. (1987) reported that Kanva-2, when cultivated with 45 x 45 cm spacing and 900 kg N per hectare improved the feeding quality of the leaves and also to great extent increased the growth rate, survival rate, cocoon yield, silk output and egg production of silkworms over other treatments.

MATERIAL AND METHODS

III. MATERIAL AND METHODS

A field experiment was conducted to study the effect of different sources of nitrogenous fertilizers on yield and quality of mulberry leaves and silkworm cocoons, at the Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore during the year 1985-86 .

The initial soil samples collected from the experimental plot, before the start of experiment and were analysed for basic physical and chemical properties. The analytical results are presented in Table 1.

3.1 Field experimental techniques

3.1.1 Layout plan of the experiment

In the study, mulberry M-5 variety was used as a test crop and Randomised Block Design was chosen (Fig.1).

Treatment details

Total eight treatments replicated three times. Nitrogen was applied in different forms viz., urea, ammonium sulphate, ammonium nitrate, calcium ammonium nitrate, combination with lime and control, at the rate of 300 kg N per hectare per year in five splits (60 kg N for each split application). 120 kgs of phosphorus and potassium applied in two split applications.

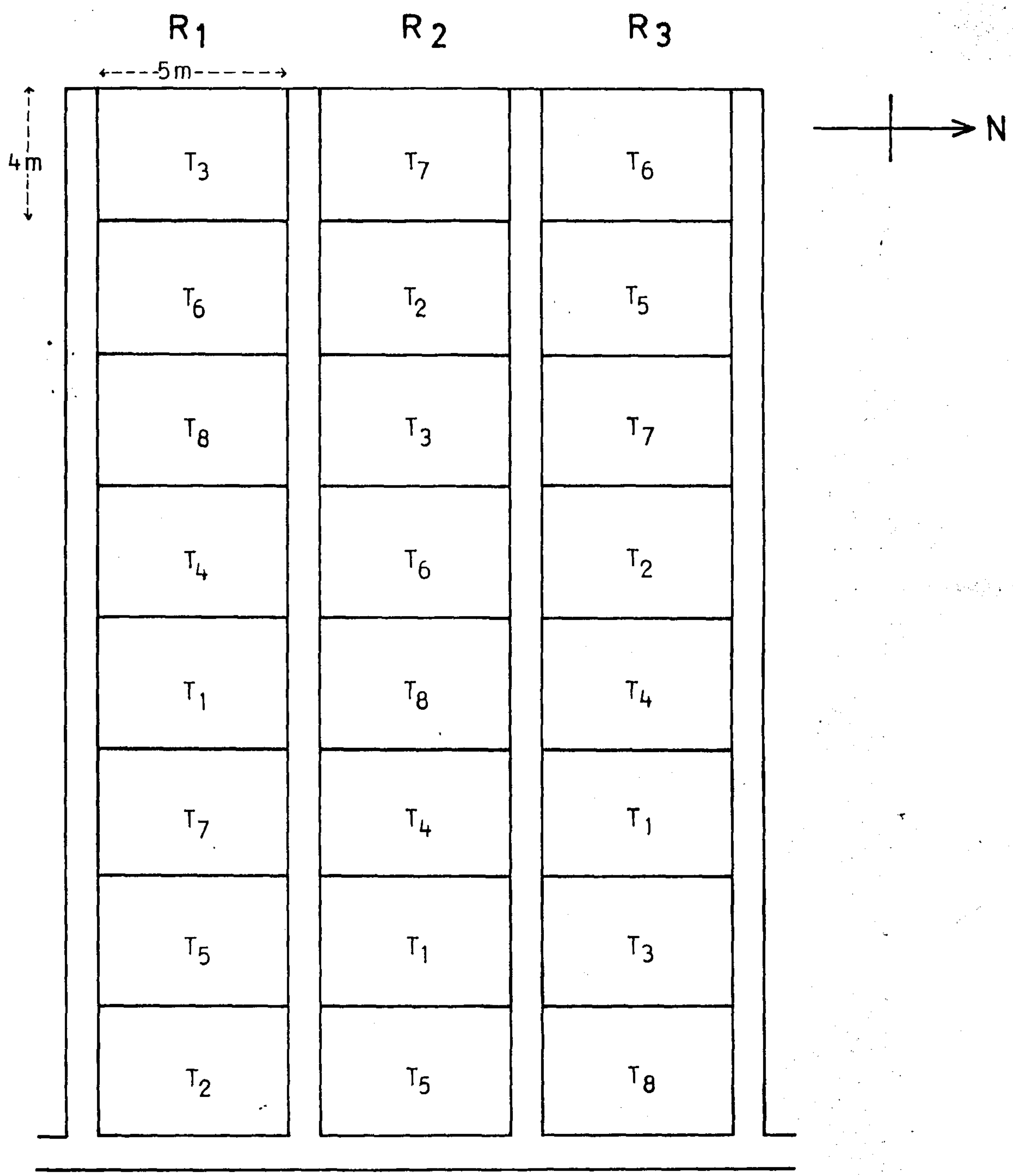

FIG. 1: PLAN AND LAY-OUT OF THE EXPERIMENTAL SITE AT MAIN RESEARCH STATION, HEBBAL, U.A.S.

The sources of phosphorus and potassium was diammonium phosphate and muriate of potash respectively. The amount of nitrogen present in the diammonium phosphate has been taken care while applying different sources of nitrogenous fertilizers.

Design	:	Simple RCBD
Treatments	:	8
Replication	:	3
Net plot size	:	20 sq.mt.(5 x 4 M^2)
Test crop	:	Mulberry, M-5
Spacing	:	60 x 22 cm

Treatments

T_1 = Urea

T_2 = Ammonium sulphate

T_3 = Ammonium nitrate

T_4 = Calcium ammonium nitrate

T_5 = Urea + Lime

T_6 = Ammonium sulphate + Lime

T_7 = Ammonium nitrate + Lime

T_8 = Control

3.1.2 Planting

An established garden was chosen for experimental purpose. After all the agronomical practices the above treatments were imposed by hand placement of fertilizers. Lime was applied in the furrows without mixing with fertilizers in the begining of the experiment. The crop was irrigated once in 10-12 days. Weeds were removed as and when they appeared. After each cutting, the plots were harrowed and the split dose of nitrogen, phosphorus and potassium was applied in bands and the crop was irrigated.

3.1.3 Planting and harvesting

First split dose of fertilizers applied on 11-8-1985. The first cutting was taken 60 days after imposing the treatment and subsequent cuttings were followed at 60 days interval. Immediately after each harvest fresh leaf weight was recorded and computed for fresh leaf yield.

3.1.4 Measurement of leaf area

Immediately after each harvest leaf area was measured from five labelled plants and computed for per plant in cm^2 by leaf area meter.

3.2 Methods of soil analysis

3.2.1 Collection and preparation of soil samples

Surface soil samples were collected from each plot, 0-45 cm depth after each cutting. The samples were dried under the shade, powdered with wooden mallet passed through a metal free 2 mm sieve and preserved in clean polythene bags for analytical work.

3.2.2 Mechanical analysis

International pipette method was followed using sodium hexametaphosphate as the dispersing agent (Piper, 1966).

3.2.3 Soil pH

Soil pH was determined in 1:2.5 soil water suspension by glass electrode using digital pH meter (Jackson, 1973).

3.2.4 Electrical conductivity

Electrical conductivity was measured in the soil water (1:2.5) extract using conductivity bridge (Jackson, 1973).

3.2.5 Organic carbon and organic matter

Organic carbon was determined by Walkley and Black's wet oxidation method as described by Jackson (1973). The per cent organic carbon multiplied with the factor 1.72 gave the per cent organic matter.

3.2.6 Available nitrogen

Available nitrogen was determined by alkaline permanganate method as described by Subbiah and Asiza (1956).

3.2.7 Total nitrogen

Total nitrogen of soil was determined by Kjeldahls method as described by Black (1965).

3.2.8 Available phosphorus

Brays No.1 extractant was used for this purpose. Five grams of soil was shaken with 50 ml extractant for 5 minutes and filtered. In the filterate phosphorus was determined by chlorostannous reduced molybdoposphoric blue colour method in HCl system. The intensity of blue colour was read on spectrophotometer at 660 nm (Perur et al., 1973).

3.2.9 Available potassium

Available potassium was determined flame photometrically from the extractant using neutral normal ammonium acetate with 1:5 soil to extractant ratio (Perur et al., 1973).

3.2.10 Exchangeable calcium and magnesium

Exchangeable calcium and magnesium were determined by titration with E.D.T.A. using suitable indicators from the extract using neutral normal ammonium acetate (Jackson, 1973).

3.3 Methods of plant analysis

Plant samples were collected from each plot at the time of each cutting using stainless steel scissors. The samples were dried in an oven at 60°C. The dried samples were powdered in a clean grinder fitted with stainless steel blades and preserved in polythene bags for further analysis.

3.3.1 Nitrogen

A sample of 0.5 g was digested in concentrated H_2SO_4 with K_2SO4 + $CuSO_4$ + Se mixture as catalyst in Kjeldahl flask and distilled in an alkaline medium. The liberated ammonia was collected in 4 per cent boric acid containing bromocresol green methyl red mixed indicator and titrated against standard sulfuric acid. From the data the per cent nitrogen was calculated (Jackson, 1973).

3.3.2 Crude protein

Crude protein content of leaves was calculated by multiplying the percentage of nitrogen by 6.25.

3.3.3 Digestion of leaf samples and extraction

A plant samples of 0.5 g was digested using triacid mixture (HNO_3 : $HClO_4$: H_2SO_4 at 10:4:1) as described by Jackson (1973). The digest was extracted with 6N HCl made up to 100 ml and the extract was used for elemental analysis.

3.3.4 Phosphorus

Phosphorus was determined in an aliquot of the plant extract by the Vanado molybdate yellow colour method in HNO_3 medium. The colour intensity was measured in the spectrophotometer at 420 nm as described by Jackson (1973).

3.3.5 Potassium

The potassium content in the digested extract was determined using flame photometer (Jackson, 1973).

3.3.6 Calcium and magnesium

Calcium and magnesium in the digest was determined by titrating an aliquot against standard E.D.T.A. solution using suitable indicators, as described by Jackson (1973).

3.3.7 Crude fibre and total minerals

Five grams of plant material was digested with 200 ml of 1.25 per cent NaOH, crude fibre and total minerals calculated according to the procedure described in A.O.A.C. (1970).

3.4 Feeding trials

3.4.1 Rearing of silkworms

Silkworm feeding trials were conducted on NB_7 Bivoltine strain. The silkworms were assigned to the different treatments from the 3rd instar onwards. One hundred worms were maintained in each replication. Two rearings were under taken. During the rearing period mean, maximum and minimum temperature and relative humidity were recorded, recommended rearing practices were followed as described by Jolly (1982).

3.4.2 Incubation of eggs

The disease free layings of NB_7 bivoltin race were purchased from National Silkworm Seed Project (NSSP). They were incubated in trays at room temperature, followed standard incubation method (Jolly, 1982).

3.4.3 Disinfection

Before the commencement of rearing the rearing room and equipments were disinfected in air-tight condition with four per cent formalin solution at the rate of 800 ml per 10 sq.mt. using a foot pump.

3.4.4 Brushing

Two layings of NB_7 were brushed seperately for each treatment, ensuring two hours after hatching by adopting direct feeding method. Larva were brushed on to wooden trays having paraffin paper at its floor and wet foam rubber strips provided all along the inner edges of trays.

3.4.5 Method of rearing

Rearing techniques recommended by the Central Sericultural Research and Training Institute, Mysore were adopted.

3.4.6 Cocoon weight, pupal weight, shell weight and shell percentage

Cocoons were harvested after fifth day from mounting and a sample of five cocoons was drawn from each replication. Individual cocoon weight was taken and the average was calculated. Same cocoon was cut open at the narrower end by a sharp blade without damaging the pupa. The pupa was separated from the shell for recording the weight of the pupa and shell (without exuvia). The shell percentage for each cocoon was calculated by using the following formula and average was recorded.

$$\text{Shell percent} = \frac{\text{Shell weight}}{\text{Cocoon weight}} \times 100$$

3.4.7 Silk filament length and denier

Another sample of five cocoons was taken from each replication and stiffled in hot air oven at 90 to 95°C for three hours. The cocoons were left in the oven with door open for 3 hours in order to remove the moisture content of the cocoons. They were stored for three days as immediate reeling would result in filament breakage. Individual cocoons were taken and cooked in boiling water for 3 to 4 minutes to soften the sericin content. Cooked cocoons were reeled out on an approvette. Number of revolutions were recorded and converted in to meters using the formula.

$$L = R \times 1.125$$

Where,

L = Total filament length m per cocoons

R = Number of revolutions

1.125= Circumstance of the approvette

The raw silk filament taken from the approvette was dried in a oven 70 to 80°C and weighed to determine the denier using the standard formula.

$$D = \frac{W}{L} \times 9000$$

Where, D = Denier

W = Weight of single cocoon reeled silk

L = Total length (m) of single cocoon filament 9000 being the constant value.

3.4.8 Statistical analysis of the data

The experimental data were analysed statistically as prescribed by Sundararaj *et al.* (1972). For silkworm rearing and reeling data, statistical analysis was not done since, composite samples was taken however mean values of these have been presented. The levels of significance used in 'F' test was P = 0.05.

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The results of the present study on the effect of different sources of nitrogenous fertilizers on the yield and quality of mulberry leaves and silkworm cocoons are presented in this chapter.

4.1 Characteristics of soil

The physcial and chemical properties of the soil of the experimental area presented in Table-1. The soils of the site at the Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore, belong to the acidic paleustalf and Tyamagondalu series. The soil is sandy loam in texture, slightly acidic in reaction (6.25 pH) with low electrical conductivity (0.24 mmhos/cm^2). The soil was medium in respect of available nitrogen (365 kgs/ha), available P_2O_5 (40.5 kg/ha) and available K_2O (170.2 kg/ha). The cation exchange capasity of the soil was 12.0 me/100gm soil and exchangeable calcium and magnesium contents were 3.60 me/100 gm and 0.80 me/100g of soil respectively.

4.2 The effect of different sources of nitrogenous fertilizers on the leaf area of mulberry

4.2.1 Leaf area

The data on different sources of nitrogenous fertilizers on leaf area are presented in Table-2 and Fig 2.

Table 1. Physical and chemical properties of the soil of the experimental site.

Property/Constituents	Composition
Mechanical composition	
Coarse sand (%)	50.22
Fine sand (%)	19.30
Silt (%)	3.74
Clay (%)	25.35
Textural class	Sandy clay loam
pH (1:2.5)	6.2
Electrical conductivity (mmhos/cm, 25°C)	0.24
C.E.C.(meq/100g)	12.00
Organic matter (%)	0.74
Available nitrogen (kg/ha)	351.00
Available P_2O_5 (kg/ha)	43.00
Available K_2O (kg/ha)	170.00
Exchange Ca^{2+} (me/100g)	3.6
Exchange Mg^{2+} (me/100g)	0.8

Table 2. Effect of different sources of nitrogenous fertilizers on average leaf area of the mulberry.

Treatments	Total leaf area (cm^2 $plant^{-1}$) in different cuttings					Mean
Urea	1471.33	1468.67	1479.33	1435.33	1433.00	1457.53
Ammonium sulphate	1094.33	1406.33	1358.67	1383.33	1389.67	1254.46
Ammonium nitrate	1193.33	1406.67	1366.33	1407.00	1400.67	1354.80
Calcium ammonium nitrate	1468.00	1591.67	1562.00	1592.67	1592.33	1561.33
Urea + Lime	1395.00	1429.33	1391.67	1430.00	1431.33	1415.46
Ammonium sulphate + Lime	1303.33	1419.00	1400.00	1419.33	1428.33	1393.99
Ammonium nitrate + Lime	1514.67	1400.00	1416.67	1413.00	1421.67	1433.20
Control	957.00	1152.00	1047.67	1270.00	1167.33	1119.20
S.Em±	32.08	22.97	25.98	18.38	15.07	-
C.D. = 0.05	97.31	69.69	78.81	57.40	45.70	-

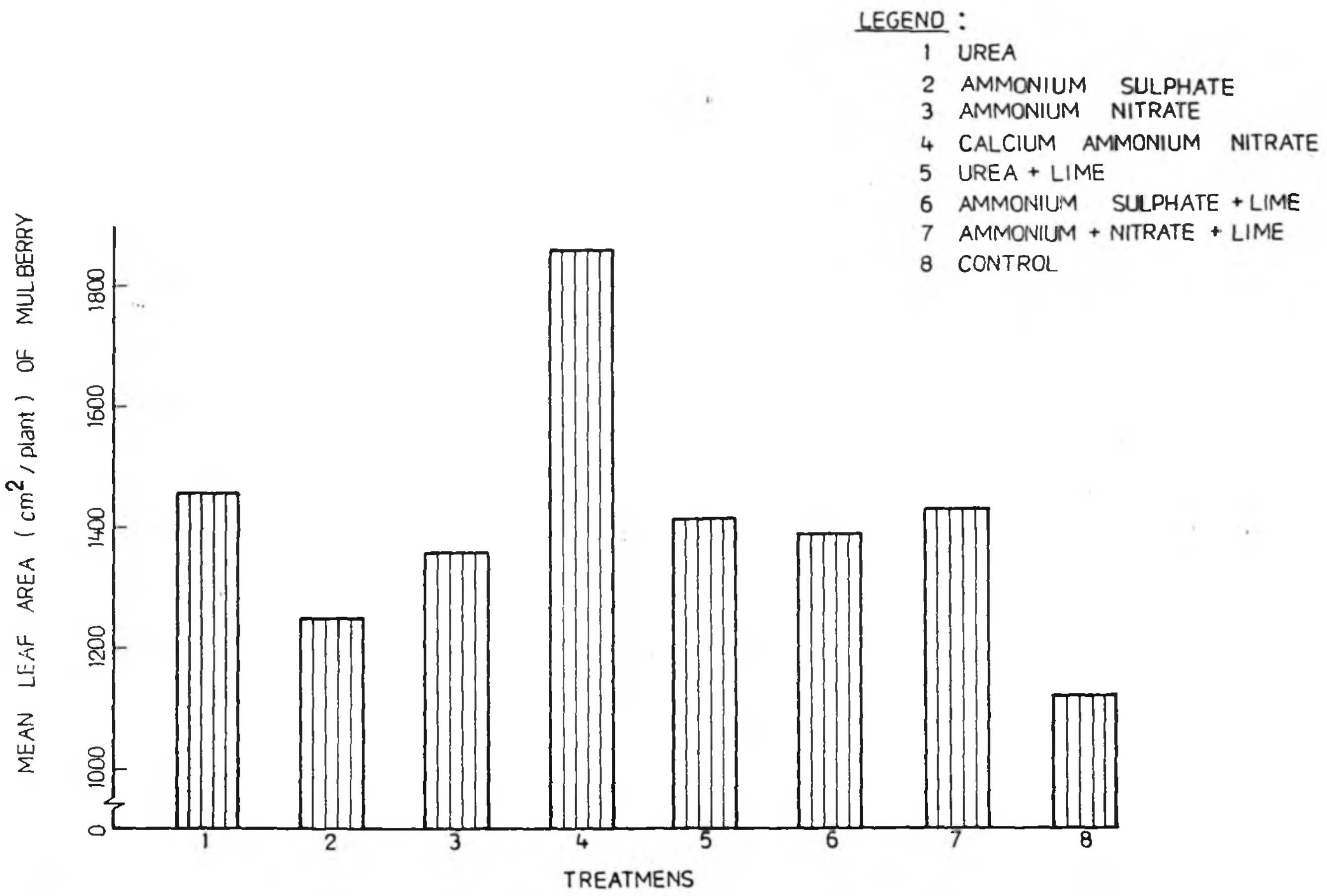

FIG. 2 : EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN LEAF AREA (cm^2/ plant) OF MULBERRY

Among the different sources of nitrogenous fertilizers used, ammonium nitrate with lime significantly increased (1514.67 cm^2) the leaf area in the first cutting over the control (957.00 cm^2). There was no significant difference between ammonium nitrate with lime (1514.67 cm^2), calcium ammonium nitrate (1468.00 cm^2) and urea (1471.33 cm^2) treatments in the first cutting.

In the second, third, fourth and fifth cuttings, leaf area was significantly higher (1591.67 cm^2, 1562.00 cm^2, 1592.67 cm^2 and 1592.33 cm^2 respectively) in the calcium ammonium nitrate treatment compared to other nitrogenous fertilizers and control.

Mean values of five cuttings revealed that calcium ammonium nitrate increased leaf area (1561.33 cm^2) followed by urea (1457.53 cm^2) and the lowest leaf area was recorded in control (1119.20 cm^2) treatment.

4.2.2 Effect of different sources of nitrogenous fertilizers on leaf yield of mulberry

The data on fresh leaf weight of mulberry due to application of different sources of nitrogenous fertilizers are presented in Table-3 and depicted in Fig 3. In the first cutting highest leaf yield was recorded in calcium ammonium nitrate (12.4 t/ha) followed by urea (10.7 t/ha). The leaf

Table 3. Effect of different sources of nitrogenous fertilizers on fresh leaf weight of mulberry.

Treatments	Yield of green leaves (t/ha) in different cuttings					Total
	1	2	3	4	5	
Urea	10.7	7.3	10.7	11.6	7.2	47.5
Ammonium sulphate	8.7	8.2	8.8	7.5	8.2	41.5
Ammonium nitrate	9.5	8.2	9.5	9.2	8.4	44.8
Calcium ammonium nitrate	12.4	10.4	12.1	9.6	9.6	54.1
Urea + Lime	8.9	8.8	8.6	10.2	9.0	45.5
Ammonium sulphate + Lime	9.0	9.1	8.4	10.2	9.2	45.9
Ammonium nitrate + Lime	8.8	9.5	8.3	11.7	9.3	47.6
Control	7.6	4.6	7.4	2.0	4.6	26.2
S.Em±	0.40	0.72	0.34	1.06	0.87	-
C.D. = 0.05	2.10	2.50	1.77	3.12	2.83	-

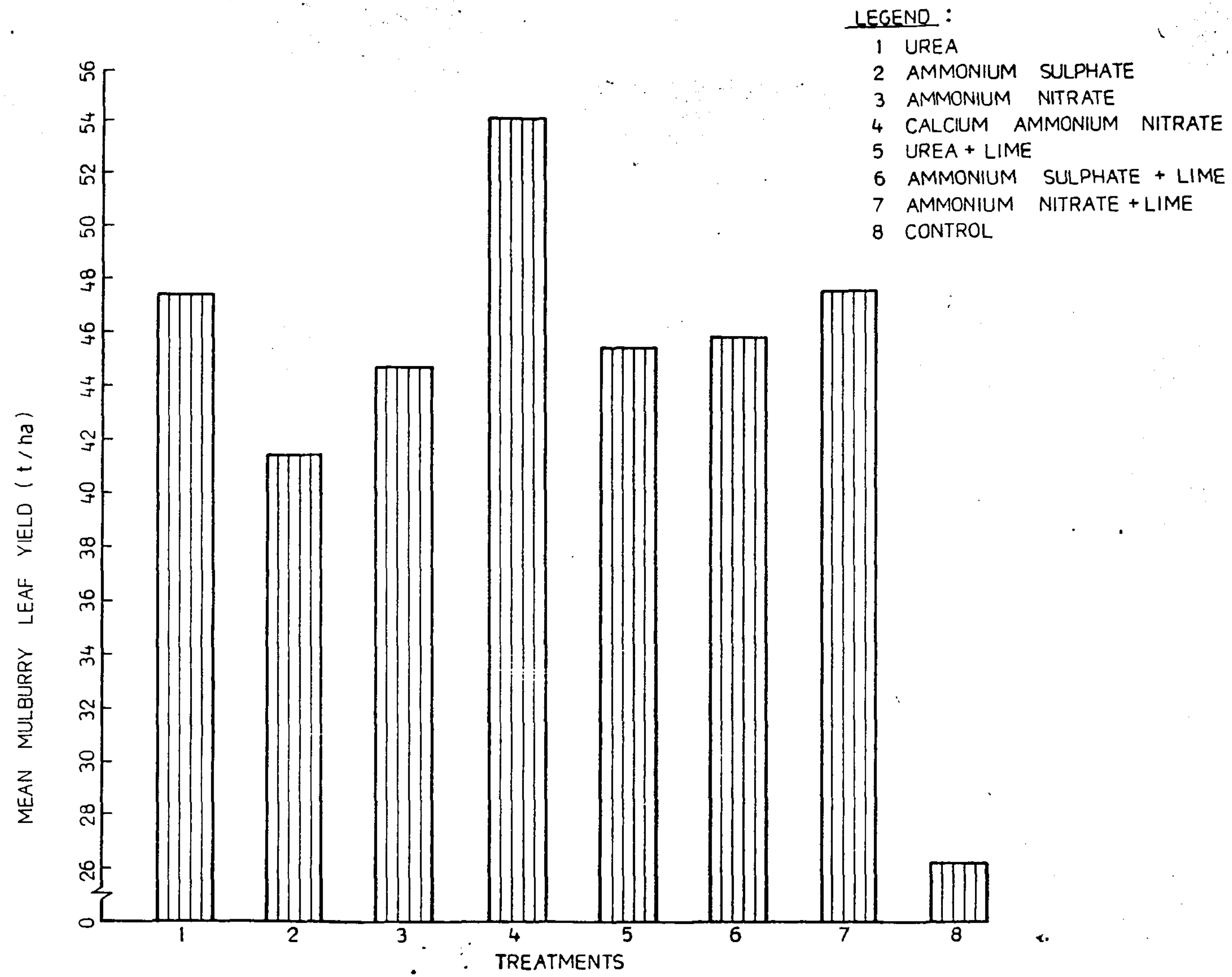

FIG. 3: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN LEAF YIELD (t/ha) OF MULBERRY

yield of calcium ammonium nitrate was significantly higher than the other treatments except urea.

In the second cutting also highest leaf yield (10.4 t/ha) was observed in calcium ammonium nitrate treatment. There was no significant increase in leaf yield among the different sources of nitrogenous fertilizers (varied from 8.2 to 9.5 t/ha) except with control and urea treatments (4.6 t/ha and 7.3 t/ha respectively), the increase in yield was significant.

Calcium ammonium nitrate tended to increase leaf yield (12.1 t/ha) significantly over the control (7.4 t/ha) and other treatments in the 3rd cutting except urea (10.7 t/ha).

In the fourth cutting, there was no significant increase in leaf yield among different sources of nitrogenous fertilizers. However, ammonium nitrate with lime and urea increased leaf yield (11.7 t/ha and 11.6 t/ha respectively) significantly over the control and ammonium sulphate (2.0 t/ha and 7.5 t/ha respectively) treatments.

Highest leaf yield (9.6 t/ha) was recorded in calcium ammonium nitrate treated plots and the yield increase was significantly higher than the control (4.6 t/ha). However, it was non-significant among the different sources of nitrogenous fertilizers in the fifth cutting.

Considering the over all performance of five cuttings per year, highest leaf yield was obtained in the treatment of calcium ammonium nitrate (54.1 t/ha) followed by urea (47.5 t/ha) and the lowest leaf yield was recorded in control (26.2 t/ha) plots.

4.3 Effect of different sources of nitrogenous fertilizers on the quality of mulberry leaves

4.3.1 Nitrogen content

The data on nitrogen content of mulberry leaves due to different sources of nitrogenous fertilizers are presented in Table-4 and Fig.4.

In the first cutting ammonium sulphate significantly increased the nitrogen content (2.46%) over control (1.88%). However, the ammonium sulphate with lime (2.41%) and ammonium nitrate with lime (2.42%) are on par with ammonium sulphate.

Application of ammonium sulphate significantly increased the nitrogen content in the leaf of second cutting (2.95%) over other nitrogenous fertilizers including control (2.18%). The similar trend was also observed in third and fifth cuttings.

In the fourth cutting also ammonium sulphate significantly increased the nitrogen (2.68%) content in the leaf followed by ammonium nitrate with lime (2.66%) treatment.

Table 4. Effect of different sources of nitrogenous fertilizers on nitrogen content of the mulberry leaves.

Treatments	Content of nitrogen(%) after different cuttings					Mean
	1	2	3	4	5	
Urea	2.32	2.70	2.69	2.36	2.15	2.44
Ammonium sulphate	2.46	2.95	3.23	2.68	2.54	2.77
Ammonium nitrate	2.18	2.63	2.76	2.40	2.43	2.48
Calcium ammonium nitrate	2.25	2.70	2.71	2.40	2.41	2.49
Urea + Lime	2.34	2.46	2.71	2.42	2.25	2.44
Ammonium sulphate + Lime	2.41	2.67	2.67	2.57	2.26	2.52
Ammonium nitrate + Lime	2.42	2.53	2.73	2.66	2.42	2.55
Control	1.83	2.18	2.40	2.11	1.87	2.08
S.Em±	0.028	0.021	0.021	0.028	0.042	-
C.D. = 0.05	0.08	0.07	0.07	0.08	0.06	-

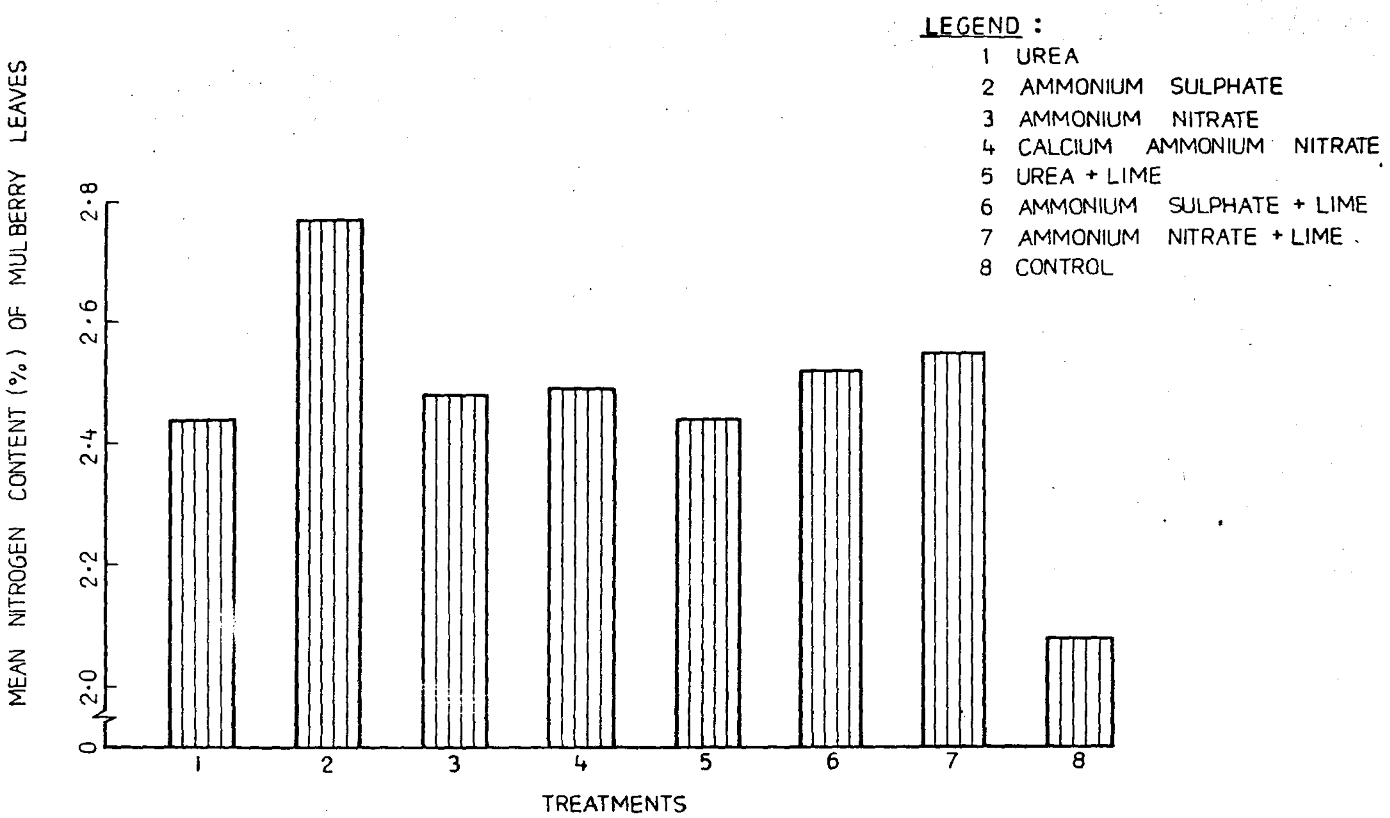

FIG.4: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN NITROGEN CONTENT (%) OF MULBERRY LEAVES

The highest nitrogen content from five cuttings was recorded with ammonium sulphate (2.77%) treatment followed by ammonium nitrate with lime (2.55%) and ammonium sulphate with lime (2.52%). However, the lowest percentage of nitrogen was recorded in the control (2.08%).

4.3.2 Crude protein content

Among the different sources of nitrogenous fertilizers (Table-5 and Fig.5), ammonium sulphate significantly increased the crude protein (15.37%) content in the first cutting of mulberry leaves over control (11.72%) and other nitrogenous fertilizers except ammonium sulphate with lime (15.04%) and ammonium nitrate with lime (15.10%).

In the subsequent second, third, fourth and fifth cuttings also ammonium sulphate significantly increased the crude protein content (18.56%, 20.16%, 16.77% and 15.87% respectively), over control (13.31%, 15.00%, 13.19% and 11.62% respectively) and other nitrogenous fertilizers except in the fourth cutting for ammonium nitrate with lime (16.60%).

In general highest crude protein content was recorded in ammonium sulphate (17.35%) treated plants followed by ammonium nitrate with lime (15.93%) and ammonium sulphate with lime (15.70%) and the lowest was observed in control (12.96%).

Table 5. Effect of different sources of nitrogenous fertilizers on crude protein content of the mulberry leaves.

Treatments	Content of crude protein(%) after different cuttings					Mean
	1	2	3	4	5	
Urea	14.47	16.87	16.79	14.77	13.43	15.26
Ammonium sulphate	15.37	18.56	20.16	16.77	15.87	17.35
Ammonium nitrate	13.60	16.45	17.25	14.98	15.20	15.50
Calcium ammonium nitrate	13.99	16.95	16.95	14.98	15.00	15.57
Urea + Lime	14.60	15.39	16.83	15.10	14.06	15.19
Ammonium sulphate + Lime	15.04	16.69	16.70	16.04	14.06	15.70
Ammonium nitrate + Lime	15.10	15.87	17.06	16.60	15.06	15.93
Control	11.72	13.31	15.00	13.19	11.62	12.96
S.Em±	0.169	0.198	0.129	0.169	0.120	-
C.D. = 0.05	0.52	0.61	0.40	0.51	0.36	-

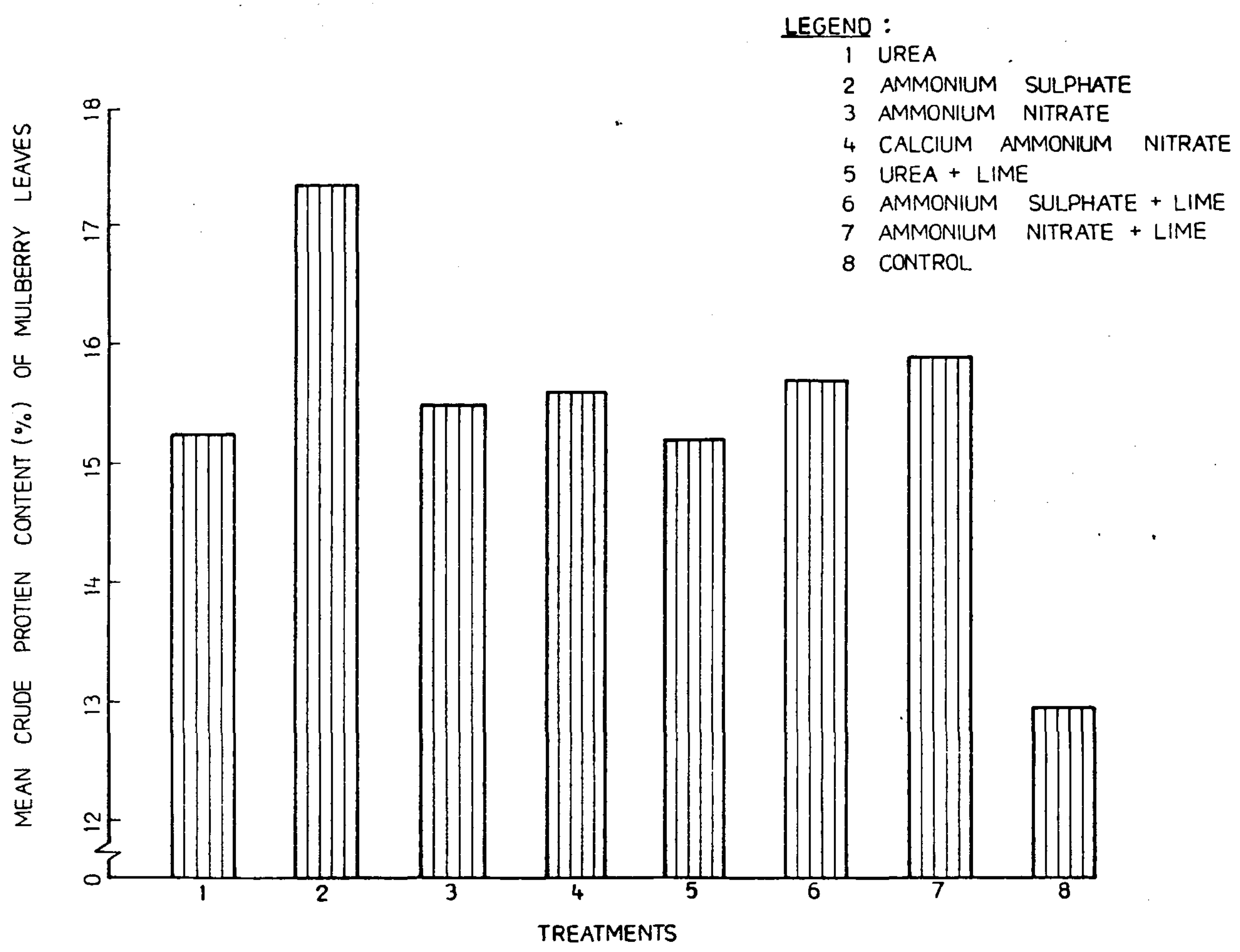

FIG. 5 : EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN CRUDE PROTEIN CONTENT(%) OF MULBERRY LEAVES

4.3.3 Phosphorus content

The data on phosphorus content of mulberry leaves at different cuttings as influenced by different sources of nitrogenous fertilizers are given in Table-6 and Fig.6.

In the first cutting application of urea with lime significantly increased the phosphorus content (0.47%) of the mulberry leaves over control (0.29%) and other nitrogenous fertilizers. But this trend was not followed in the remaining four cuttings. Considering the other four cuttings, the phosphorus content of the mulberry leaves in the calcium ammonium nitrate treated plots was significantly higher (0.47%, 0.47%, 0.38% and 0.41%) when compared to all other treatments.

Considering the mean value of phosphorus content in the leaves of the different cuttings, the highest (0.41%) was recorded in calcium ammonium nitrate followed by urea with lime (0.39%) and the lowest phosphorus (0.31%) value was recorded in the leaves of the control plot.

4.3.4 Potassium content

The data presented in Table-7 and Fig.7, indicated that potassium content in the leaves of the different cuttings was significantly higher in calcium ammonium nitrate treated plants (1.82%, 1.85%, 1.78%, 1.62% and 1.65%) as compared to other

Table 6. Effect of different sources of nitrogenous fertilizers on phosphorus content of the mulberry leaves.

Treatments	Content of phosphorus (%) after different cuttings					Mean
	1	2	3	4	5	
Urea	0.42	0.40	0.36	0.33	0.36	0.37
Ammonium sulphate	0.42	0.38	0.41	0.35	0.36	0.38
Ammonium nitrate	0.40	0.39	0.40	0.37	0.35	0.38
Calcium ammonium nitrate	0.33	0.47	0.47	0.38	0.41	0.41
Urea + Lime	0.47	0.39	0.39	0.37	0.35	0.39
Ammonium sulphate + Lime	0.33	0.43	0.34	0.36	0.35	0.36
Ammonium nitrate + Lime	0.42	0.41	0.38	0.36	0.39	0.39
Control	0.29	0.35	0.32	0.29	0.29	0.31
S.Em±	0.007	0.014	0.014	0.007	0.007	-
C.D. = 0.05	0.03	0.03	0.05	0.02	0.03	-

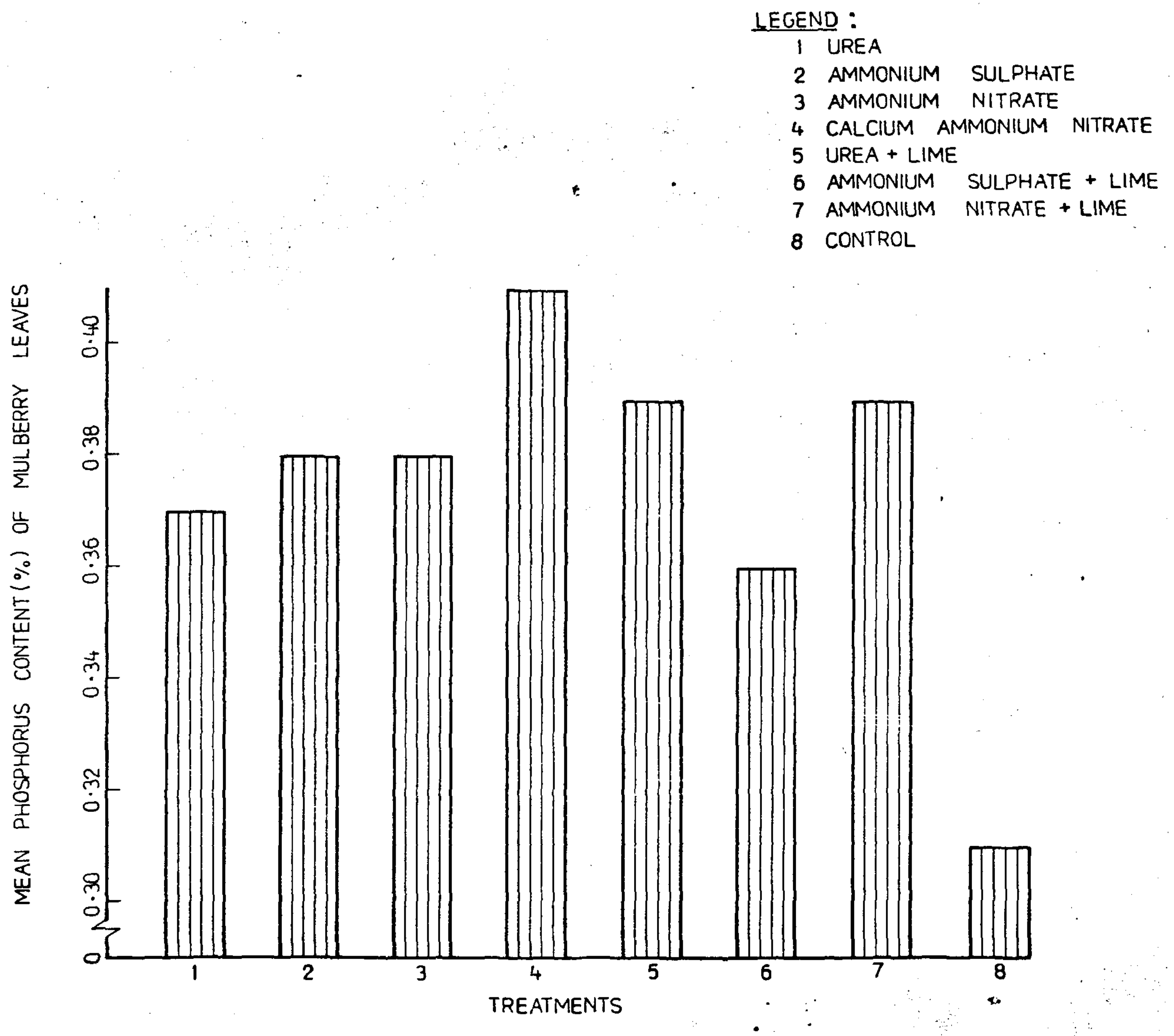

FIG.6: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN PHOSPHORUS CONTENT (%) OF MULBERRY LEAVES

Table 7. Effect of different sources of nitrogenous fertilizers on potassium content of the mulberry leaves.

Treatments	Content of potassium(%) after different cuttings(on dry wt. basis)					Mean
	1	2	3	4	5	
Urea	1.78	1.65	1.71	1.54	1.64	1.66
Ammonium sulphate	1.76	1.67	1.65	1.46	1.46	1.60
Ammonium nitrate	1.63	1.68	1.66	1.56	1.56	1.61
Calcium ammonium nitrate	1.82	1.85	1.78	1.62	1.65	1.74
Urea + Lime	1.76	1.74	1.64	1.54	1.52	1.68
Ammonium sulphate + Lime	1.81	1.71	1.63	1.46	1.43	1.61
Ammonium nitrate + Lime	1.79	1.63	1.65	1.54	1.56	1.63
Control	1.58	1.56	1.44	1.42	1.41	1.48
S.Em±	0.049	0.007	0.014	0.014	0.014	-
C.D. = 0.05	0.14	0.03	0.04	0.03	0.04	-

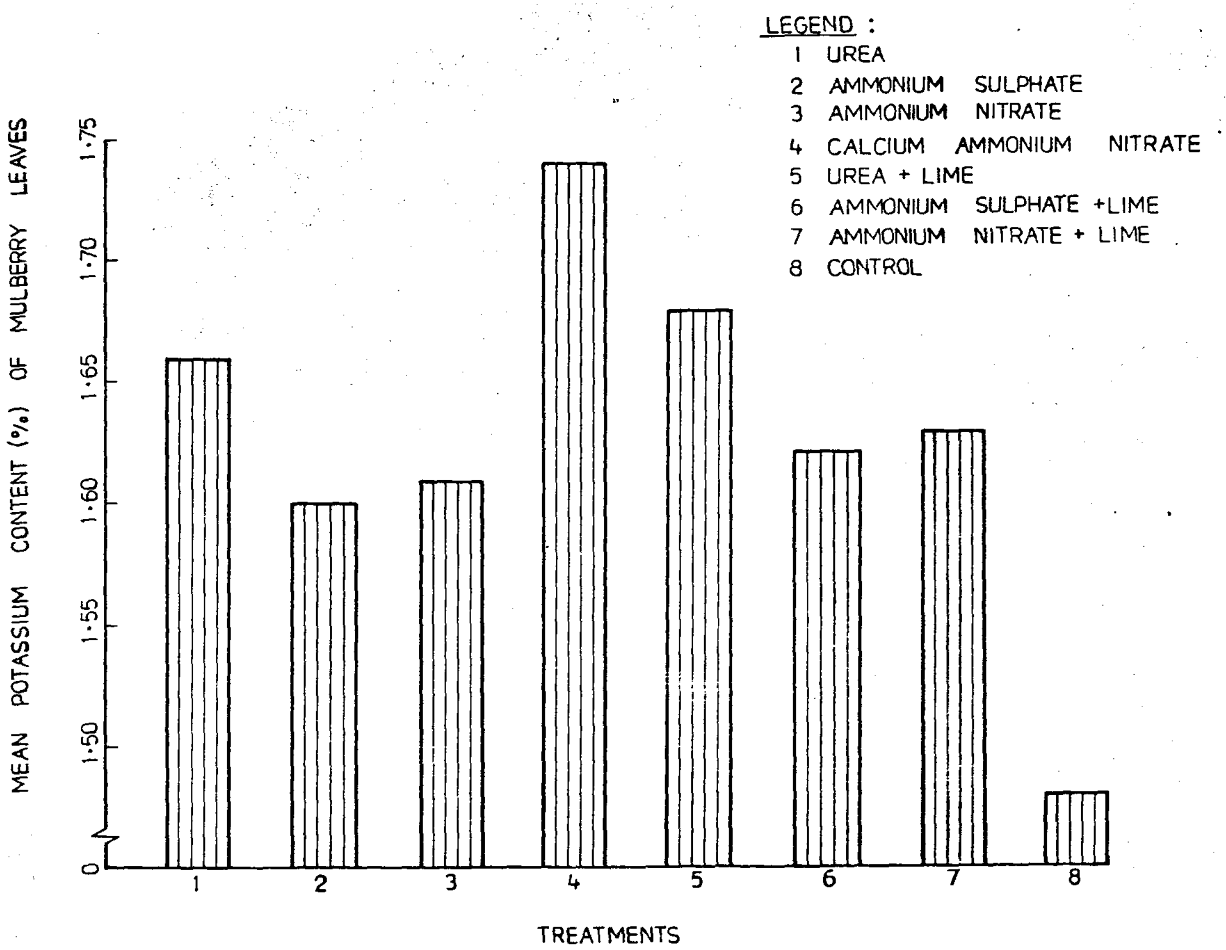

FIG.7: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN POTASSIUM CONTENT (%) OF MULBERRY LEAVES

different forms of nitrogen fertilizers except urea treatment in the fifth cutting (1.64%). The content of potassium in the urea treated leaves was on par with the calcium ammonium nitrate treated leaves.

By considering the overall five cuttings, the data indicated that calcium ammonium nitrate treated plants had higher potassium content (1.74%) followed by urea with lime (1.68%), urea (1.66%) and the lowest potassium content was observed in control (1.48%).

4.3.5 Calcium content

Results of the calcium content in different cuttings are presented in Table-8 and Fig.8.

The differences in calcium content of the mulberry leaves among the treatments in all the cuttings were non-significant.

In general calcium ammonium nitrate and other nitrogenous fertilizers with lime treated plants showed higher calcium content (1.15%) as compared to other nitrogenous fertilizers with no lime and the lowest was observed in control and urea (1.13%).

Table 8. Effect of different sources of nitrogenous fertilizers on clacium content of the mulberry leaves.

Treatments	Content of calcium(%) after different cuttings					Mean
	1	2	3	4	5	
Urea	1.14	1.14	1.13	1.13	1.13	1.13
Ammonium sulphate	1.14	1.14	1.14	1.14	1.14	1.14
Ammonium nitrate	1.15	1.14	1.13	1.13	1.13	1.14
Calcium ammonium nitrate	1.16	1.16	1.15	1.15	1.15	1.15
Urea + Lime	1.15	1.16	1.14	1.16	1.15	1.15
Ammonium sulphate + Lime	1.16	1.16	1.15	1.15	1.15	1.15
Ammonium nitrate + Lime	1.16	1.15	1.15	1.15	1.15	1.15
Control	1.14	1.14	1.13	1.13	1.13	1.13
S.Em±	0.005	0.005	0.005	0.005	0.005	-
C.D. = 0.05	NS	NS	NS	NS	NS	-

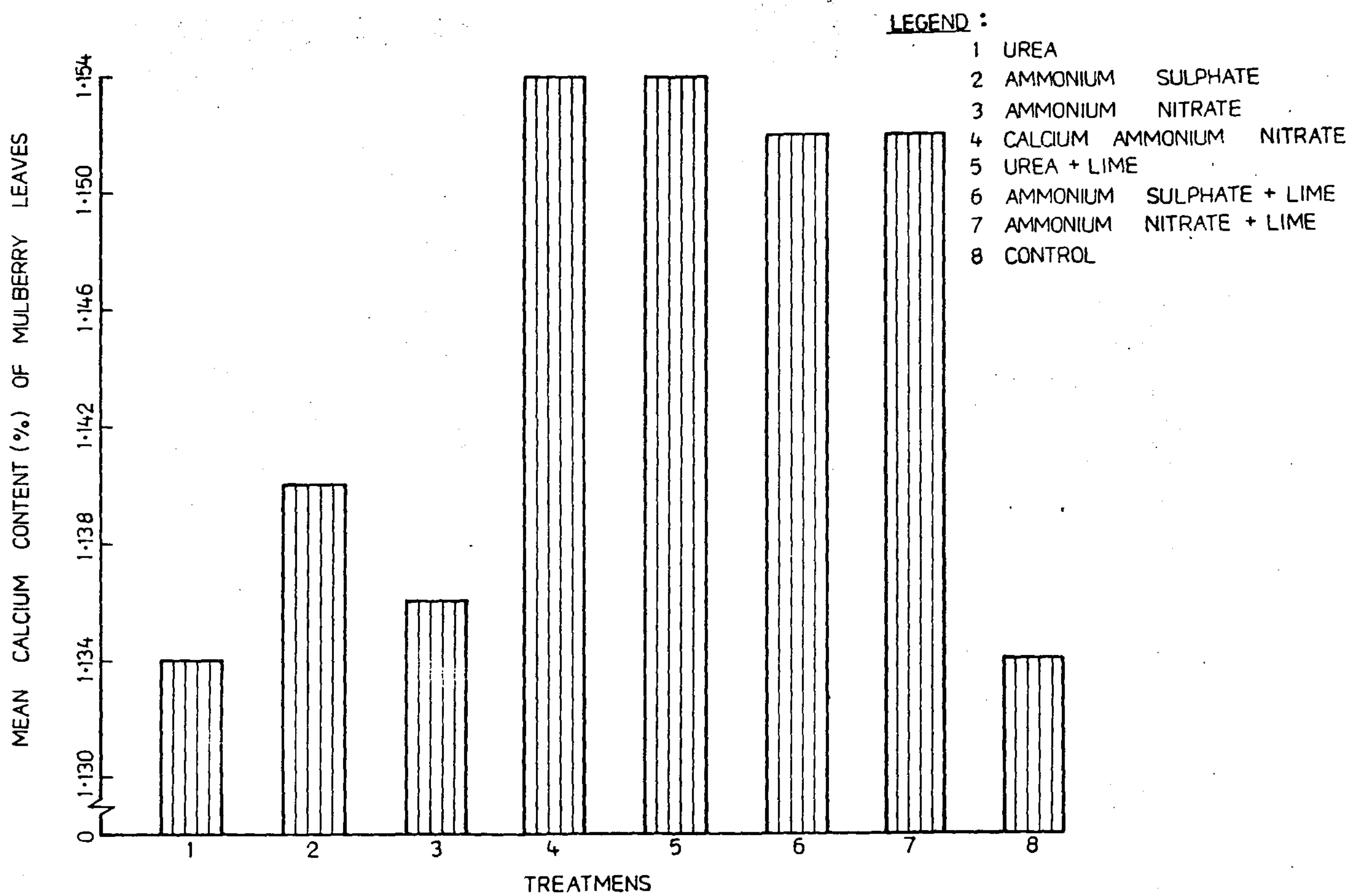

FIG.8 : EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN CALCIUM CONTENT (%) OF MULBERRY LEAVES

4.3.6 Magnesium content

Results of the magnesium content of the mulberry leaves at different sources of nitrogenous fertilizers are presented in Table 9.

There was no significant variation in magnesium content in any of the cuttings by applying different sources of nitrogenous fertilizers. However, is varied from 0.67 per cent in control to 0.69 per cent in urea.

4.3.7 Crude fibre content

Crude fibre content was found to be highest in calcium ammonium nitrate (10.20%) treatment (Table 10 and Fig.9). It was significantly higher than the other treatments and the lowest crude fibre content (9.0%) was recorded in control plots in the first cutting. Similar results were also obtained in second (10.15%) and fifth (10.10%) cuttings.

Calcium ammonium nitrate tended to increase the crude fibre (10.03%) content significantly higher compared to all the treatments except urea treated plots in the third cutting (9.85%).

In the fourth cutting except, urea with lime treated plants (10.18%), calcium ammonium nitrate significantly increased the crude fiber content (10.35%) compared to other treatments.

Table 9. Effect of different sources of nitrogenous fertilizers on magnesium content of the mulberry leaves.

Treatments	Content of magnesium(%) after different cuttings					Mean
	1	2	3	4	5	
Urea	0.70	0.70	0.69	0.68	0.68	0.69
Ammonium sulphate	0.70	0.70	0.69	0.68	0.68	0.69
Ammonium nitrate	0.69	0.69	0.69	0.69	0.69	0.69
Calcium ammonium nitrate	0.69	0.69	0.68	0.68	0.67	0.68
Urea + Lime	0.68	0.68	0.67	0.67	0.67	0.67
Ammonium sulphate + Lime	0.68	0.68	0.67	0.66	0.67	0.67
Ammonium nitrate + Lime	0.69	0.69	0.67	0.66	0.67	0.68
Control	0.68	0.68	0.66	0.66	0.66	0.67
S.Em±	0.005	0.005	0.005	0.005	0.004	-
C.D. = 0.05	NS	NS	NS	NS	NS	-

Table 10. Effect of different sources of nitrogenous fertilizers on crude fibre content of the mulberry leaves.

Treatments	Content of crude fibre(%) after different cuttings					Mean
	1	2	3	4	5	
Urea	10.01	9.78	9.85	10.02	9.79	9.89
Ammonium sulphate	9.96	9.32	9.62	9.81	9.56	9.65
Ammonium nitrate	9.88	9.13	9.50	9.56	9.73	9.56
Calcium ammonium nitrate	10.20	10.15	10.03	10.35	10.10	10.16
Urea + Lime	9.92	9.56	9.26	10.18	9.75	9.73
Ammonium sulphate + Lime	9.67	9.65	9.35	9.93	9.52	9.62
Ammonium nitrate + Lime	9.87	9.40	9.19	10.09	9.37	9.58
Control	9.00	9.03	8.92	9.00	8.99	8.98
S.Em±	0.049	0.070	0.070	0.077	0.070	-
C.D. = 0.05	0.14	0.22	0.22	0.24	0.23	-

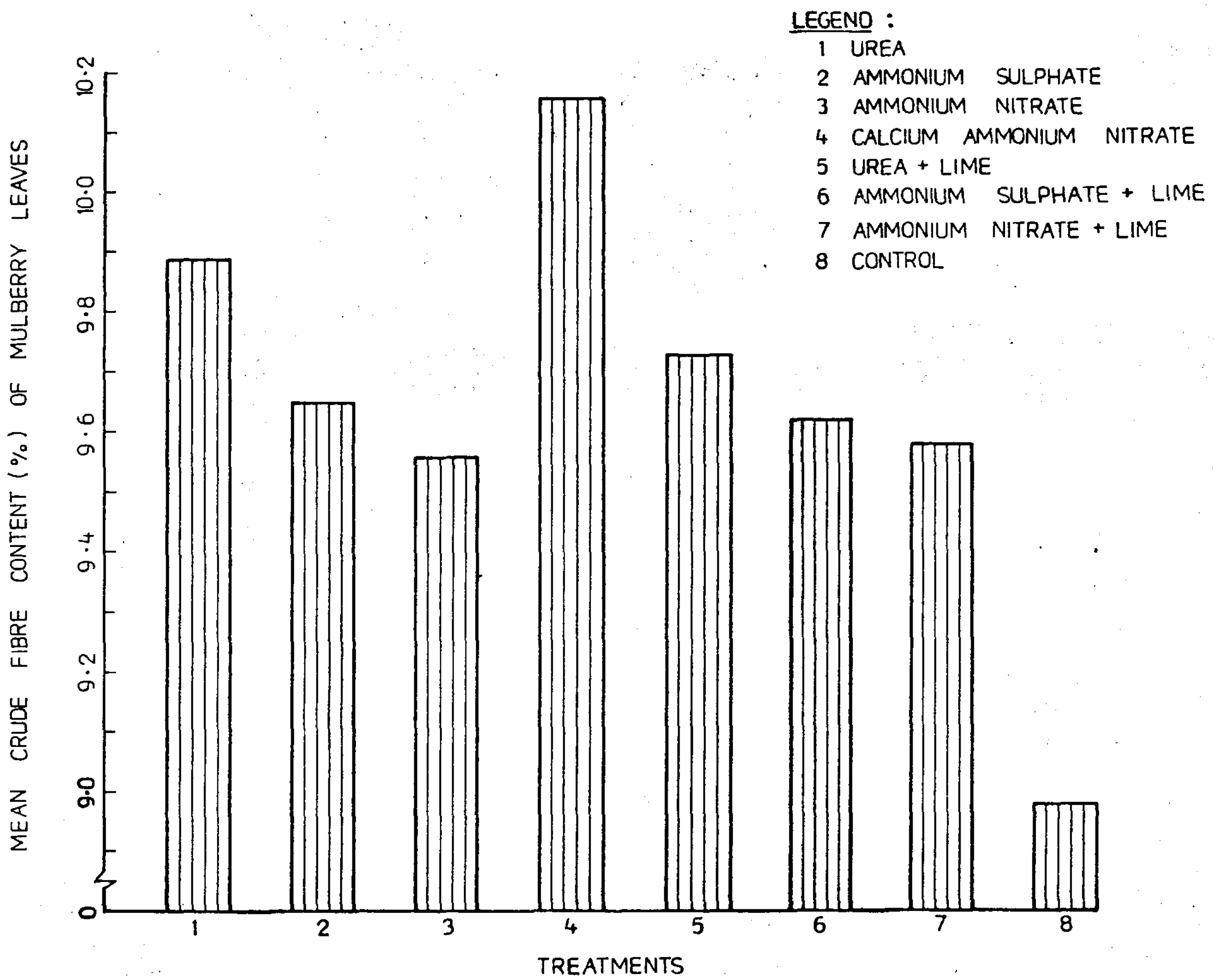

FIG. 9: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN CRUDE FIBRE CONTENT(%) OF MULBERRY LEAVES

On an average, calcium ammonium nitrate increased crude fibre content (10.16%) followed by urea (9.89%) and urea with lime treatments (9.73%) and the lowest crude fibre (8.98%) content was recorded in control.

4.3.8 Total minerals content

The results of the total minerals content was presented in Table-11 and Fig.10.

From the table we can see that calcium ammonium nitrate significantly superior in increasing the total mineral content (12.51%) compared to other treatments except it is on par with urea (12.20%) and ammonium sulphate with lime treatment (12.21%) in the case of first cutting. While in the second cutting the calcium ammonium nitrate also increased the total mineral content (13.38%) and it is significantly higher than the other treatments except it is on par with urea (13.09%), urea with lime (13.01%) and ammonium sulphate with lime (13.08%).

There was no significant difference in total minerals content between the different sources of nitrogenous fertilizers in the third cutting, however calcium ammonium nitrate recorded the highest total minerals content (12.43%). The lowest total minerals content (11.63%) was recorded in the control plots and it was found significantly lower when compared to all the nitrogenous fertilizer treatments.

Table 11. Effect of different sources of nitrogenous fertilizers on total minerals content of the mulberry leaves.

Treatments	Content of total minerals (%) after different cuttings					Mean
	1	2	3	4	5	
Urea	12.20	13.09	12.24	13.19	13.15	12.74
Ammonium sulphate	12.05	12.81	12.15	12.96	12.99	12.59
Ammonium nitrate	12.08	12.60	12.14	12.91	12.85	12.51
Calcium ammonium nitrate	12.51	13.38	12.43	13.40	13.45	13.03
Urea + Lime	11.82	13.01	12.16	13.27	13.10	12.68
Ammonium sulphate + Lime	12.21	13.08	12.16	13.20	13.11	12.75
Ammonium nitrate + Lime	12.03	12.08	12.08	13.11	13.21	12.50
Control	10.96	11.73	11.63	11.99	11.99	11.66
S.Em±	0.106	0.134	0.127	0.035	0.070	-
C.D. = 0.05	0.32	0.40	0.38	0.12	0.22	-

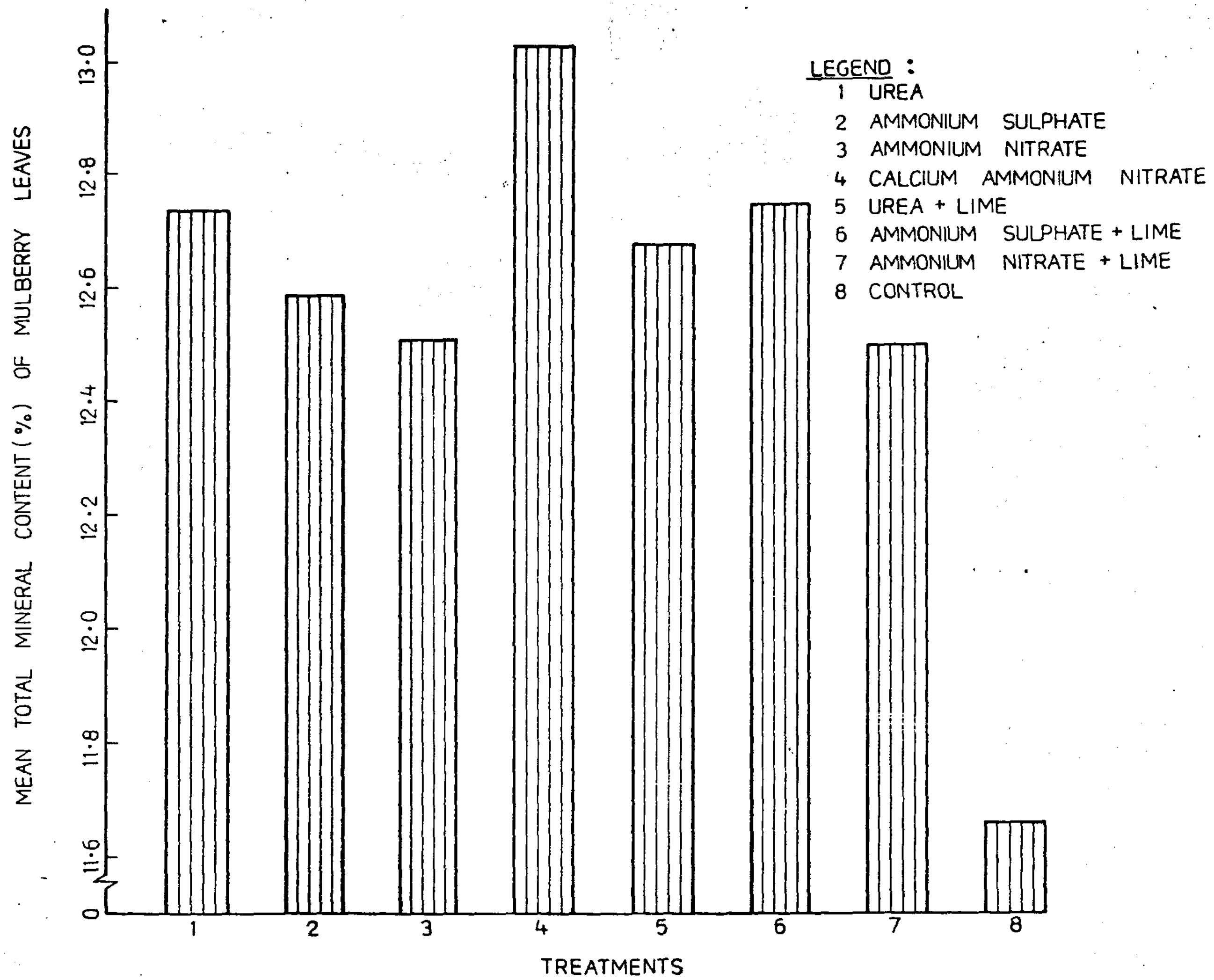

FIG.10: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN TOTAL MINERALS CONTENT (%) OF MULBERRY LEAVES

In the fourth and fifth cuttings calcium ammonium nitrate increased the total mineral content (13.40% and 13.45%; respectively) and it was significantly higher than the all other treatments. In general control plots showed the lowest mineral content (11.66%) and calcium ammonium nitrate showed the highest (13.03%).

4.4 Effect of different sources of nitrogenous fertilizers on yield and quality of cocoons

The data on cocoon weight and other commercial characters are presented in Table-12 and Fig. 11, 12 and 13.

Data on cocoon weight indicate that feeding of silkworms with mulberry leaves that were fertilized with calcium ammonium nitrate increased cocoon weight to 1.596g from 1.428g in control. It was followed by ammonium sulphate with lime (1.554g), urea (1.526g) and urea with lime (1.521g).

Silkworms fed with mulberry leaves, fertilized with different sources of nitrogenous fertilizers did not cause any significant variation in pupal weight. However, the highest pupal weight was recorded in calcium ammonium nitrate treatment (1.292g) and the lowest was recorded in control (1.206g).

Table 12. Effect of different sources of nitrogenous fertilizers on yield and quality of cocoons.

Treatments	Cocoon characters				
	Cocoon wt.(g)	Pupal wt.(g)	Shell wt.(g)	Shell percentage	Filament length(m)
Urea	1.526	1.259	0.248	16.33	820.00
Ammonium sulphate	1.451	1.218	0.226	15.57	786.95
Ammonium nitrate	1.473	1.215	0.229	16.36	784.30
lcium ammonium rate	1.596	1.292	0.409	16.66	850.00
+ Lime	1.521	1.276	0.246	15.58	808.00
nium sulphate +	1.554	1.274	0.248	16.00	846.80
ium nitrate +	1.487	1.230	0.227	15.22	811.80
	1.428	1.206	0.216	15.03	756.60

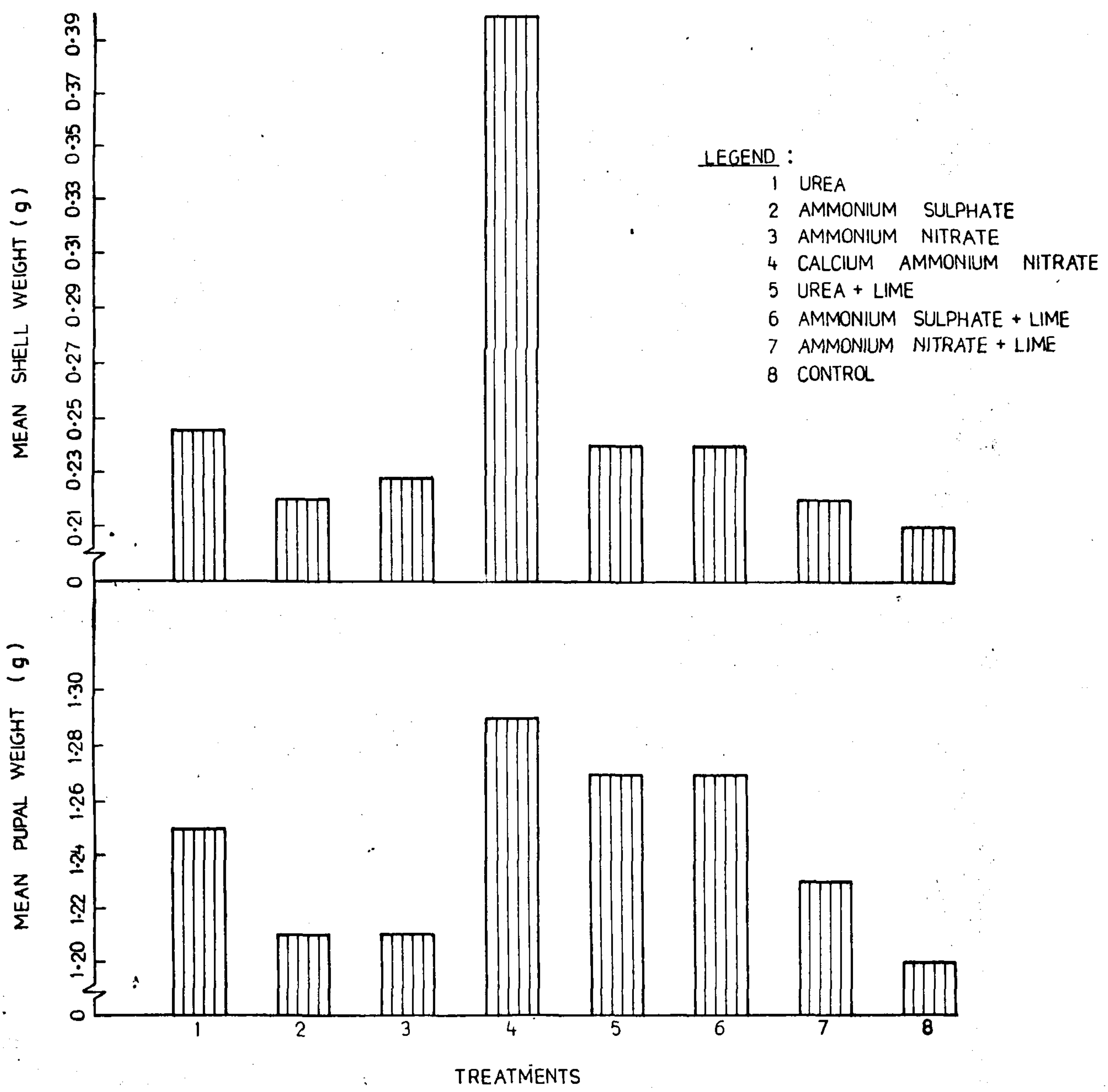

FIG.11: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN SHELL WEIGHT (g) AND MEAN PUPAL WEIGHT (g)

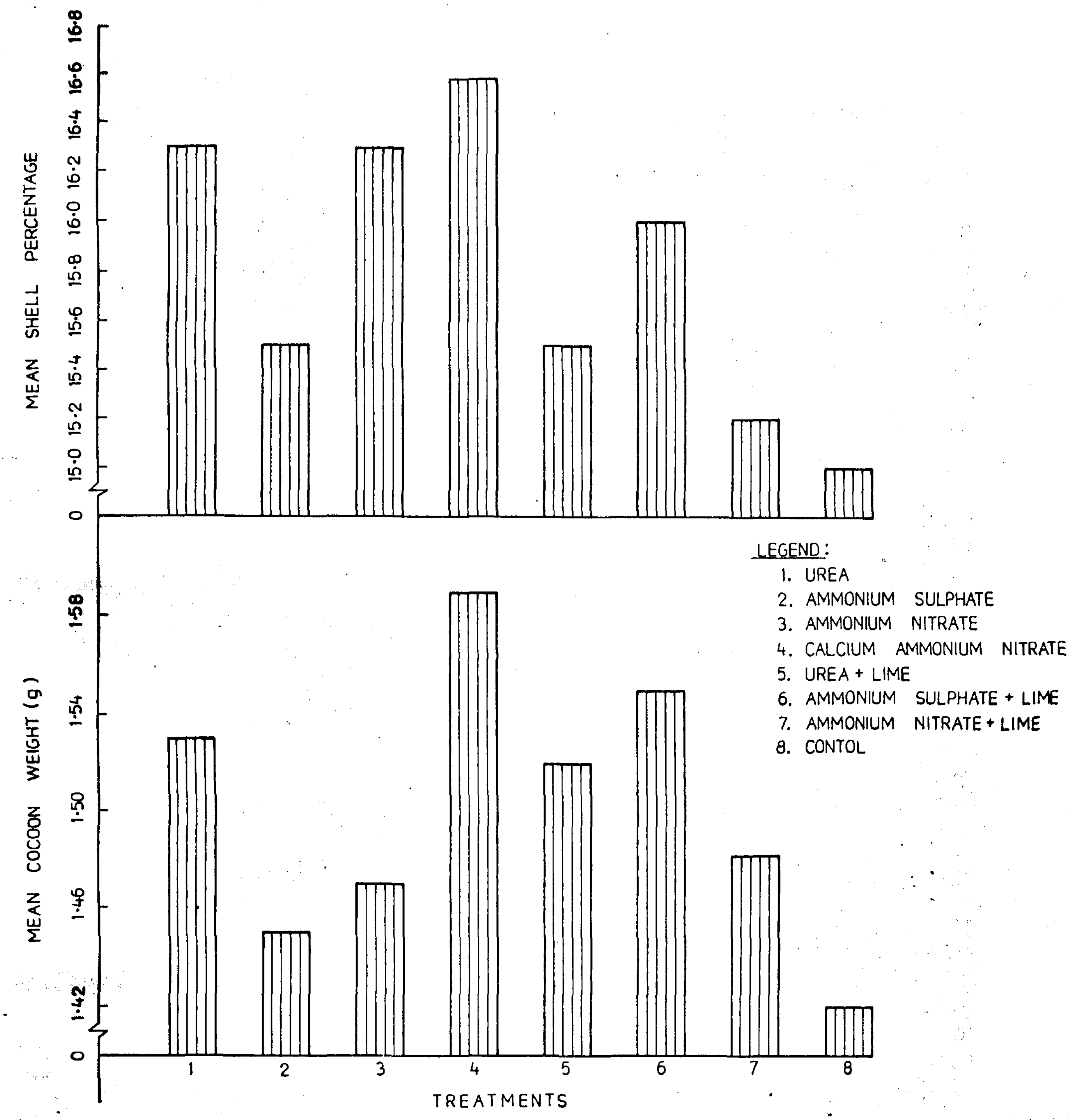

FIG.12: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN SHELL PERCENTAGE AND MEAN COCOON WEIGHT (g)

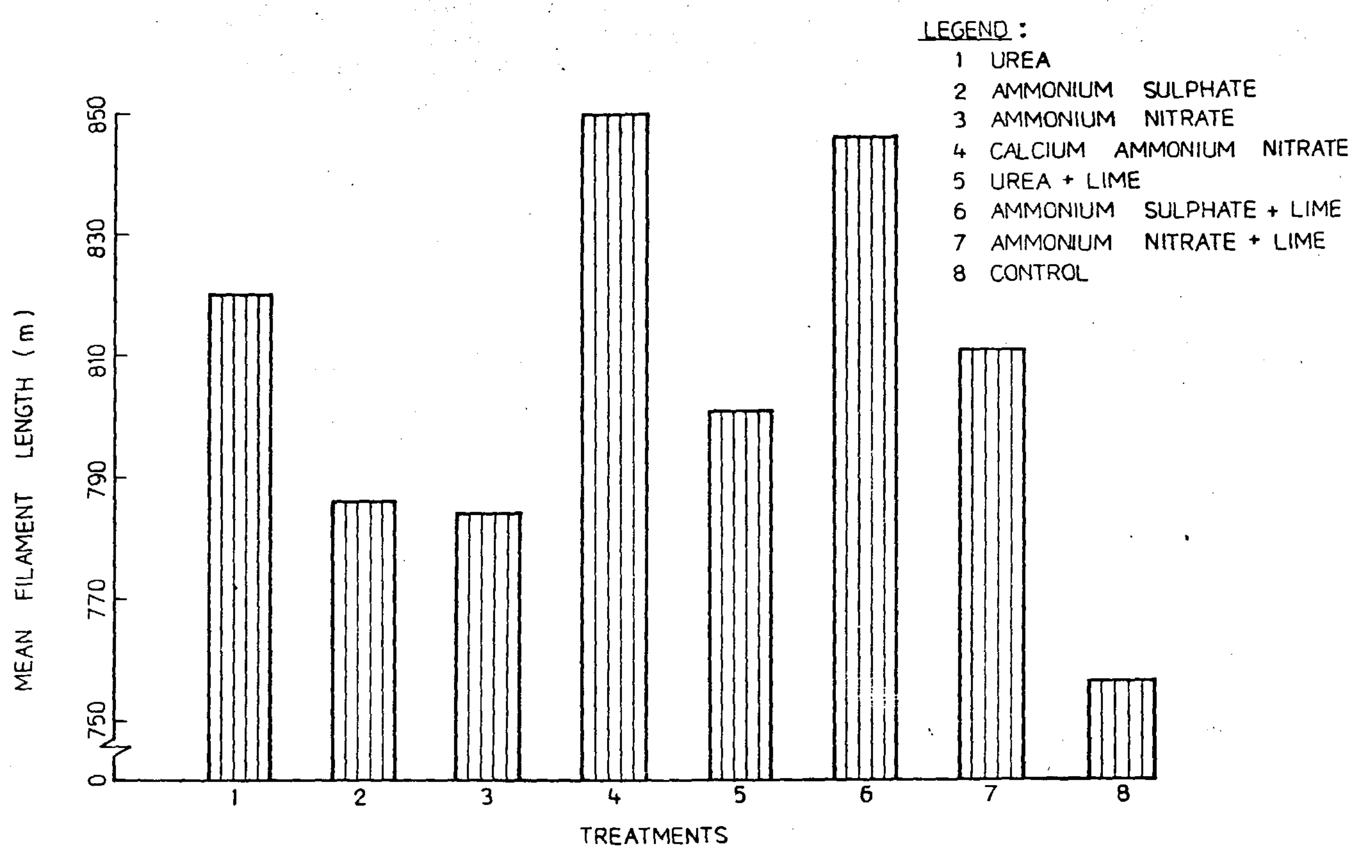

FIG.13: EFFECT OF DIFFERENT SOURCES OF NITROGENOUS FERTILIZERS ON MEAN FILAMENT LENGTH

Feeding of silkworms with mulberry leaves fertilized with calcium ammonium nitrate recorded highest in shell weight (0.409g) followed by ammonium sulphate with lime and urea (0.248g), urea with lime (0.246g) and in the remaining treatments it was almost equal and higher than the control (0.216g).

Shell percentage increased from 15.03 in control to 16.66 in calcium ammonium nitrate treatment. There was slight variation among other nitrogenous fertilizers and it vary from 15.22 (Ammonium nitrate with lime) to 16.36 (Ammonium nitrate). Higher filament length was observed (850.00 m) in the silkworms fed with calcium ammonium nitrate followed by ammonium sulphate with lime (846.80 m), urea (820.00 m) and the lowest was in control (756.60 m). In general all the silkworms fed with leaves fertilized with nitrogenous fertilizers were superior in filament length as compared to control.

DISCUSSION

V. DISCUSSION

The effect of different sources of nitrogenous fertilizers on growth, yield and quality of mulberry leaves, and inturn its effect on silkworm cocoon characters and yield have been discussed here in the light of a few earlier findings.

5.1 Effect of different sources of nitrogenous fertilizers on the yield of mulberry leaves

The data on different sources of nitrogenous fertilizers on leaf area are presented in table 2 and fig.2 reveal that, among the different sources of nitrogenous fertilizers used ammonium nitrate with lime increased (1514.67 cm^2) the leaf area in the first cutting over the control (957.00 cm^2). There was no significant difference between ammonium nitrate with lime (1514.67 cm^2), calcium ammonium nitrate (1468.00 cm^2) and urea (1471.33 cm^2) treatments in the first cutting. In the second, third, fourth and fifth cuttings leaf area was significantly higher (1591.67 cm^2, 1562.00 cm^2, 1592.67 cm^2 and 1592.33 cm^2 respectively) in the calcium ammonium nitrate treatment compared to other nitrogenous fertilizers. Mean values of five cuttings revealed that calcium ammonium nitrate increased leaf area (1561.33 cm^2) followed by urea (1457.53 cm^2 and the lowest leaf area was recorded in control (1119.20 cm^2)

treatment. In the past not much work has been reported on the effect of fertilizers on leaf area of mulberry, however Manchashetty (1979) observed that fertilizer NPK application to the soil and also foliar feeding of nitrogen through urea caused rapid increase in leaf area.

The data on fresh leaf weight of mulberry due to application of different sources of nitrogenous fertilizers are presented in Table-3 and depicted in Fig.3. In the first cutting highest leaf yield was recorded in calcium ammonium nitrate (12.4 t/ha) followed by urea (10.7 t/ha). The leaf yield of calcium ammonium nitrate was significantly higher than the other treatments except urea. In the second cutting also highest leaf yield (10.4 t/ha) was observed in calcium ammonium nitrate treatment but it was not significant with the other sources of nitrogenous fertilizers (varied from 8.2 to 9.5 t/ha) except with control (4.6 t/ha) and urea (7.3 t/ha) treatments. Calcium ammonium nitrate tended to increase leaf yield (12.1 t/ha) significantly over the control (7.4 t/ha) and other treatments in the 3rd cutting except urea (10.7 t/ha) treatment. In the fourth cutting there was no significant increase in leaf yield among different sources of nitrogenous fertilizers however ammonium nitrate + lime and urea increased leaf yield (11.7 t/ha and 11.6 t/ha respectively) significantly over the control and ammonium sulphate (2.0 t/ha and 7.5 t/ha respectively) treatments. Highest leaf yield (9.6 t/ha) was recorded in calcium ammonium nitrate treated plots and the increase in yield was significantly higher than the control (4.6 t/ha) but it was insignificant among the different sources of nitrogenous fertilizers in the fifth cutting.

Considering the over all performance of five cuttings per year the highest leaf yield was obtained in the treatment of calcium ammonium nitrate (54.1 t/ha) followed by urea (47.5 t/ha) and the lowest leaf yield was recorded in control (26.2 t/ha) plots. The experimental results are in confirmity with the findings of Murthy (1953), Iruthyraj and Rajarathnam (1965), Kasiviswanathan and Sitaram Iyengar (1968), Ray et al. (1973) and Anonymous (1986).

5.2 Effect of different sources of nitrogenous fertilizers on the quality of mulberry leaves

It is observed from the data presented in Table-4 and Fig.4, that application of ammonium sulphate significantly increased the nitrogen content (2.46%) over control (1.83%). However the ammonium sulphate with lime (2.41%) and ammonium nitrate with lime (2.42%) are on par with ammonium sulphate in the first cutting. Application of ammonium sulphate significantly increased the nitrogen content in the leaf of second cutting (2.95%) over other nitrogenous fertilizers including control (2.18%). A similar trend was also observed in third and fifth cuttings. In the fourth cutting also ammonium sulphate significantly increased the nitrogen (2.68%) content in the leaf followed by ammonium nitrate with lime (2.66%) treatment. The highest nitrogen content from five cuttings was recorded with ammonium sulphate (2.77%) treatments followed by ammonium nitrate with lime (2.55%) and ammonium sulphate with lime (2.52%) and the lowest percentage of nitrogen was recorded in the control (2.08%). Similar findings were also reported by Prince (1959), Grunes and Kranz (1958), Mathis et al. (1973) in some field crops and Mancheshetty (1979) in mulberry.

Among the different sources of nitrogenous fertilizers (Table 5 and Fig.5), ammonium sulphate significantly increased the crude protein (15.37%) content in the first cutting over control (11.72%) and other nitrogenous fertilizers except ammonium sulphate with lime (15.04%) and ammonium nitrate with lime (15.10%). In the subsequent cuttings (second, third, fourth and fifth) also ammonium sulphate significantly increased the crude protein content (18.56%, 20.16%, 16.77% and 15.87% respectively) over other nitrogenous fertilizers and control (13.31%, 15.00%, 13.19% and 11.62% respectively) except in the fourth cutting for ammonium nitrate with lime (16.60%). In general highest crude protein content was recorded in ammonium sulphate (17.35%) treated plants followed by ammonium nitrate with lime (15.93%) and ammonium sulphate with lime (15.70%) and the lowest was observed in control(12.96%). Basavanna et al. (1974) found that application of 900 kg N per hectare increased the crude protein content by 3.89 per cent , further the author also revealed that Kanva variety spaced at 45 x 10cm with a nitrogen level of 300 kg per hectare was considerably increased the crude protein. Similar trend of increased crude protein by application of nitrogen and combination with P and K was also reported by Anonymous (1976) and Manchashetty (1979).

The data furnished in Table-6 and Fig.6 indicate that in first cutting urea with lime significantly increased the phosphorus content (0.47%) of the mulberry leaves, but this was not followed in the remaining four cuttings. Considering the other four cuttings, the phosphorus content of the mulberry leaves in the calcium ammonium nitrate treated plots was significantly higher (0.47%, 0.47%, 0.38% and 0.41%), when compared to all other treatments. Considering the mean values of phosphorus content in the leaves of the different cuttings the highest phosphorus (0.41%) was recorded in calcium ammonium nitrate followed by urea with lime (0.39%) and the lowest phosphorus (0.31%) value was recorded in the leaves of the control plots. Grunes (1959) reported that addition of nitrogen ous fertilizers has marked effects on the absorption of soil and fertilizer phosphorus by plants. The addition of ammonical nitrogen fertilizers rather than nitrate nitrogen fertilizers increased phosphorus absorption. Nitrogen salts may influence absorption of phosphorus by plants altering the phosphorus solubility in soil. Further, Westfall et al. (1973) reported that increase in nitrogen application increased the phosphorus uptake due to increase in root growth and higher absorption capacity of roots.

The data presented in Table-7 and Fig.7, indicated that potassium content in the leaves of the different cuttings was significantly higher in calcium ammonium nitrate treated plants (1.82%, 1.85%, 1.78%, 1.62% and 1.65%) as compared to other different forms of nitrogenous fertilizers except urea treatment in the fifth cutting. The content of potassium in the leaves was on par with the urea treated leaves. By considering the overall five cuttings it indicated that calcium ammonium nitrate treated plants had higher potassium content (1.74%) followed by urea with lime (1.68%), urea (1.66%) and the lowest potassium content was observed in control (1.48%). Increase in potassium by application of nitrogen was also reported by Prince (1954), Grunes and Krantz (1958) and Gopalaswami and Raj (1972).

The data furnished in Table-8 and Fig.8, indicated that application of different sources of nitrogenous fertilizers on calcium content of mulberry leaves in all the five cuttings were non-significant. However lowest calcium percentage was recorded in control and urea treated plants (1.134%). In general calcium ammonium nitrate, urea with lime and ammonium sulphate with lime treated plants showed little increased calcium percentage (1.154%) followed by ammonium nitrate with lime (1.152%)

The data presented in Table-9 reveal that there was no significant difference of magnesium content among the treatments in any of the cuttings by applying different sources of nitrogenous fertilizers. However in the control plants magnesium percentage was found lowest.

Crude fibre content was found to be highest in calcium ammonium nitrate (10.20%) treatment. It was significantly higher than the other treatments and the lowest crude fibre content (9.0%) was recorded in control plots in the first cutting (Table-10 and Fig.9). Similar results were also obtained in second (10.15%) and fifth (10.10%) cuttings. Calcium ammonium nitrate tended to increase the crude fibre (10.03%) content significantly higher compared to all the treatments except urea treated plots in the third cutting. In the fourth cutting except urea with lime treated plants, calcium ammonium nitrate significantly increased the crude fibre content (10.35%) compared to other treatments. On an average of five cuttings calcium ammonium nitrate increased crude fibre content (10.16%) followed by urea (9.89%) and urea with lime treatments (9.73%) and the lowest crude fibre (8.98%) content was recorded in control.

The data presented in Table-11 and Fig.10, indicated that calcium ammonium nitrate significantly superior in increasing the total mineral content (12.51%) compared to other treatments except, it is on par with urea and ammonium sulphate with lime treatment in the case of first cutting. Similar trend was also noticed in the second cutting, calcium ammonium nitrate increased the total mineral content (13.38%) and it is significantly higher than the other treatments except it is on par with urea, urea with lime and ammonium sulphate with lime. There was no significant difference between the different sources of nitrogenous fertilizers in third cutting for total mineral content. However, lowest total mineral content (11.63%) was recorded in the control plots and it was significantly lower when compared to all other treatments. In the fourth and fifth cuttings calcium ammonium nitrate increased the total mineral content (13.40% and 13.45% respectively) and it was significantly higher than the all other treatments. In general control plots showed the lowest mineral content (11.66%) and calcium ammonium nitrate showed highest (13.03%). Manchashetty (1979) observed that, increase in mineral matter due to application of basal NPK fertilizers and foliar spray of different sources of nitrogenous fertilizers and the relative performance was in the order of urea calcium ammonium nitrate $(NH_4)_2SO_4$.

5.3 Effect of different sources of nitrogenous fertilizers on yield and quality of cocoons

The commercial characters of silkworm cocoons like cocoon weight, shell weight, shell percentage and filament length are presented in Table-12 and Fig.11, 12 and 13. It could be seen from the table that maximum cocoon weight (1.596g) was recorded in the worms fed with the mulberry leaves fertilized with calcium ammonium nitrate followed by ammonium sulphate with lime (1.554g), urea (1.526g) and the lowest was recorded in the control plot (1.428g). Similarly pupal weight increase was high in the calcium ammonium nitrate treatment (1.292g) followed by urea with lime (1.276g) and ammonium sulphate with lime (1.274g) and the lowest was observed in control (1.206g). Similar trend was also observed in the case of shell weight, shell percentage and filament length. Highest shell weight was recorded in the calcium ammonium nitrate treatment (0.409g) followed by urea and ammonium sulphat with lime (0.248g) and urea with lime (0.246g). The shell percentage and filament length were also higher (16.66 and 850m respectively) in the calcium ammonium nitrate treatment followed by urea (16.33 and 820m), ammonium nitrate, ammonium sulphate with lime and the lowest was observed in control (15.03 and 756.60m respectively).

Considering the overall performance of cocoon yield and the commercial characters of cocoon, calcium ammonium nitrate exerted favourable influence compared to the other nitrogenous fertilizers, calcium ammonium nitrate is a physiologically neutral fertilizer which supplies both calcium and nitrogen and ensures balanced uptake of these nutrients. This ultimately improves quality and yield of mulberry leaves (higher crude protein, total minerals and crude fibre content). When nutritionally balanced mulberry leaves are fed to the silkworms inturn it increases the cocoon weight shell weight, shell percentage and filament length. The findings of Narayana _et al_. (1966) revealed that feeding of silkworms with leaves grown under nitrogen fertilization significantly increased the cocoon weight and shell weight. Kasiviswanathan and his associates (1970), Krishnaswami _et al_. (1971), Sengupta _et al_. (1973), Manchashetty (1979) and Venugopal Pillai _et al_. (1987) also observed similar findings of increased cocoon yield and its quality parameters by the application of nitrogenous fertilizers. The present study also reveal that the application of nitrogenous fertilizers not only increased cocoon yield but also improve the commercial cocoon characters. Further among nitrogenous fertilizers calcium ammonium nitrate exerted a favourable influence followed by lime with nitrogenous fertilizers in a slightly acidic soils of Main Research Station, Hebbal, Bangalore.

Horie and Ito (1965) demonstrated that larvae of silkworms were unable to grow and survive without diatary supply of minerals (K, P, Mg and Fe). Calcium is essential for silkworms and it accelerated the growth, while there is a general similarity among insect species in their requirement and dose of each element. The present study also indicate that calcium ammonium nitrate and lime with nitrogenous fertilizers increased cocoon weight and quality parameters.

SUMMARY

VI. SUMMARY

A replicated field trial to study the effect of diferent sources of nitrogenous fertilizers viz., urea, ammonium sulphate, ammonium nitrate, calcium ammonium nitrate, urea + lime, ammonium sulphate + lime, ammonium nitrate + lime against a control on the yield and quality of mulberry and cocoons, was carried out on a red sandy loam soils, at Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore.

To assess the nutritive value of leaves a bivoltine race NB_7 was employed for rearing purposes.

The results of the experiment is summarised in the following pages.

1. Calcium ammonium nitrate increased leaf area followed by urea and the lowest leaf area was recorded in control.

2. Significant increase in leaf yield was recorded in almost all the cuttings of mulberry in calcium ammonium nitrate treated plants followed by urea treatment, lowest was recorded in control.

3. Ammonium sulphate had a significant effect in increasing the nitrogen concentration of mulberry leaves.

4. On an average over 5 cuttings of mulberry ammonium sulphate treatment had a significant effect in increasing the crude protein content.

5. Calcium ammonium nitrate and urea + lime treatments significantly increased the phosphorus concentration of mulberry leaves.

6. Among the different sources of nitrogenous fertilizers calcium ammonium nitrate treated plants increased potassium concentration of mulberry leaves followed by urea with lime.

7. The effect of different sources of nitrogenous fertilizers on calcium and magnesium concentration of mulberry leaves was insignificant.

8. Calcium ammonium nitrate increased the crude fibre content of mulberry leaves significantly over other treatments.

9. The response for total mineral (Ash) content to different sources of nitrogenous fertilizers revealed that calcium ammonium nitrate had a significant effect.

10. Calcium ammonium nitrate was superior to other nitrogenous fertilizers in getting better cocoon yield and commercial characters of cocoon like pupal weight, shell weight, shell percentage and filament length, in two rearings of silkworms.

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VII. REFERENCES

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