

EFFECT OF SOME CULTURAL PRACTICES ON
PRODUCTION OF COWPEA-SUDANGRASS
MIXTURE IN CALCAREOUS SOIL

By

Thanaa Abass Mohamed

A thesis submitted in partial fulfillment
of
the requirement for the degree of

DOCTOR OF PHILOSOPHY

in

Agriculture
(Agronomy)

631-84
Th A

Department of Agronomy
Faculty of Agriculture
Ain Shams University

1992

APPROVAL SHEET

EFFECT OF SOME CULTURAL PRACTICES ON PRODUCTION OF
COWPEA-SUDANGRASS MIXTURE IN CALCAREOUS SOIL

BY

Thanaa Abass Mohamed

B. Sc. Agric., (Agronomy), Cairo Univ., 1966

M. Sc. Agric., (Agronomy), Cairo Univ., 1981

This thesis for Ph. D. degree has been approved by:

Prof. Dr. A.M. Hegazi .*A.. M.. Hegazi*

Prof. of Agronomy and Head of Ecology and Cultivation of
Dry Land Division, Desert Research Center.

Prof. Dr. A.M.A Abo Shetaia .*Adel . Abo . shetaia*

Prof. of Agronomy, Ain Shams Univ.

Prof. Dr. A.A. Abd El-Gawad*el-Gawad*.....

Prof. of Agronomy, Ain Shams Univ.

Date of examination 18/5/1992



EFFECT OF SOME CULTURAL PRACTICES ON PRODUCTION OF
COWPEA-SUDANGRASS MIXTURE IN CALCAREOUS SOIL

By

Thanaa Abass Mohamed

B. Sc. Agric. (Agronomy), Cairo Univ., 1966

M. Sc. Agric. (Agronomy), Cairo Univ., 1981

Under the supervision of:

Prof. Dr. A.A. Abd El-Gawad

Prof. of Agronomy, Ain Shams Univ.

Dr. M.A. Abd El-Gawad

Associate Prof. and Head of Agronomy Unit, Desert
Research Center

ABSTRACT

Two field experiments were carried out in Agricultural Research Station at Maryout, D.R.C., during 1988 and 1989 growing seasons, to study the effect of organic manure, nitrogen fertilization and different intercropping patterns of cowpea and sudangrass plants on fresh and dry forage yields, some growth characters, competitive relationships and the chemical composition.

The results can be summarized as follows:

1. Organic manure application at a rate of 20 m³/fed. increased significantly fresh and dry forage yield of cowpea and sudangrass and their mixture, SLW at the first cut, leaf/stem ratio at the first and second cuts, solar energy conversion at 2nd cut, crude protein percentage at 1st cut, total carbohydrate % at the 1st and 2nd cuts, crude fiber % at 2nd and 3rd cuts, crude protein, total carbohydrate and ash yields of cowpea. Sudangrass plant height at 1st cut, stem diameter at 3rd cut, leaf area/plant at 2nd cut, leaf/stem ratio at 1st cut, solar energy conversion at all cuts, crude protein % at all cuts, total carbohydrate % at 1st and 2nd and crude fiber % at 3rd cut, crude protein, total carbohydrate, crude fiber and ash yields/fed. increased significantly due to organic manuring.

2. Increasing nitrogen fertilization levels increased significantly fresh, dry forage yield of cowpea and sudangrass and their mixture. Cowpea plant height at 1st and 3rd cuts, leaf area/plant in all cuts, solar energy conversion % at 1st and 3rd cuts, crude protein % in all cuts, crude fiber % in 2nd and 3rd cuts, protein,

carbohydrate, crude fiber and ash yields increased significantly by nitrogen fertilization level up to 135 kg/fed. As for sudangrass plant height, stem diameter, leaf area/plant, solar energy conversion %, crude protein percentage at the three cuts as well as crude protein, total carbohydrate, crude fiber and ash/fed.

3. Intercropping patterns generally, caused a significant increase in dry forage yield of cowpea, fresh and dry forage yield of sudangrass, the fresh and dry yield of the mixture. Cowpea plant height at 2nd and 3rd cuts, stem diameter at 3rd cut, leaf area/plant at 2nd and 3rd cuts, SLW at 1st and 2nd cuts, leaf/stem ratio at 3rd cut, solar energy conversion % at 1st and 3rd cuts, crude protein % at 2nd and 3rd cuts, total carbohydrate % at the three cuts, crude fiber % at the three cuts, ash % at 1st cut, crude fiber were increased significantly when cowpea intercropping with sudangrass under different patterns. With regard to sudangrass characters as affected by intercropping patterns. It is noteworthy to mention that fresh and dry forage yield and the fresh and dry yield of the mixture, plant height at the 2nd cut, stem diameter in 2nd and 3rd cuts, leaf area/plant in 2nd and 3rd cuts, SLW at 1st and 3rd cuts, leaf/stem ratio at 2nd and 3rd cuts, solar energy conversion at 2nd and 3rd cuts, crude protein % in the three cuts, total carbohydrate % at 2nd cut, crude fiber % at all cuts, ash % at all cuts, crude protein, total carbohydrate, crude fiber and ash/fed. were increased by intercropping patterns. The best patterns were 2:1 for obtaining the best results for cowpea while 1:2 and 1:3 were suitable for gain the highest result for sudangrass, but for the fresh dry mixture yield, 1:3 pattern surpassed the other intercropping patterns and pure stand of both cowpea and sudangrass.

The data of competitive relationships showed that cowpea and sudangrass alternated dominated and dominant positions in the different patterns. Sudangrass had the highest values of relative crowding coefficient and land equivalent ratio, generally, organic manure and nitrogen fertilization increased land usage by 43% with 1:3 pattern and 12.95% with 2:1 pattern with adding 20 m³ OM/fed. and 67.5 kg N/fed., respectively.

ACKNOWLEDGEMENT

The author wishes to express her profound gratitude and appreciation to Prof. Dr. A.A. Abd El-Gawad, Prof. of Agronomy, Faculty of Agric., Ain Shams Univ., and to Prof. Dr. M.A. Abd El-Gawad, Professor and Head of Agronomy Unit, Desert Research Center (D.R.C.), for their suggesting the problem, supervising this study, progressive criticism, continuous help and thoughtful guidance.

Deep thanks are due to Prof. Dr. A.M. Hegazi, Head of Ecology and Cultivation of Dry Land Division, D.R.C., for his interest during carrying out this work.

The author wishes to express her congraturation to Dr. H. Kh. Hassan, Researcher in Agronomy Unit, Desert Research Center, for his sharing in producing this work and his sincer helpful during carrying out this work.

Thanks are also extended to all members of Agronomy Unit, D.R.C. for their kind interest.

Deep thanks are to my Family.

CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	3
1. Effect of organic manure on yield and growth	3
2. Effect of nitrogen fertilization	7
2.1. Effect of nitrogen fertilization on growth of grasses	7
2.2. Effect of nitrogen fertilization on chemical com- position of grasses	8
2.3. Effect of nitrogen fertilization on yield of grasses.	10
2.4. Effect of nitrogen fertilization on growth characters of legumes	11
2.5. Effect of nitrogen fertilization on chemical com- position of legumes	13
2.6. Effect of nitrogen fertilization on yield and yield component of legumes	13
3. Effect of intercropping patterns on yield, growth and competitive relationships	16
4. Solar energy conversion	29
MATERIALS AND METHODS	34
RESULTS AND DISCUSSION	42
I. Yield and yield components	42
I.1. Fresh forage yield	42
I.1.1. Effect of organic manure	42
I.1.2. Effect of nitrogen levels	44
I.1.3. Effect of intercropping patterns	46
I.2. Dry forage yield	48
I.2.1. Effect of organic manure	50
I.2.2. Effect of nitrogen levels	52
I.2.3. Effect of intercropping patterns	54
2. Interaction effect on yield	57
2.1. Effect of organic manure and nitrogen level inter- action on fresh forage yield	57
2.2. Effect of organic manure and nitrogen level inter- action on dry forage yield	61
2.3. Effect of organic manure and intercropping patterns interaction on fresh forage yield	62
2.4. Effect of organic manure and intercropping patterns interaction on dry forage yield	65

Cont.:

	Page
2.5. Effect of nitrogen levels and intercropping patterns interaction on fresh forage yield	67
2.6. Effect of nitrogen fertilization and intercropping patterns interaction on accumulated dry forage yield.	72
3. Effect of organic manure, nitrogen fertilization and intercropping patterns on botanical composition	75
3.1. Effect of organic manure	75
3.2. Effect of nitrogen levels	77
3.3. Effect of intercropping patterns	79
4. Yield components of forage	80
4.1. Quality characteristics of cowpea forage	80
4.1.1. Plant height	80
4.1.2. Stem diameter	83
4.1.3. Leaf area/plant	84
4.1.4. Specific leaf weight (SLW)	86
4.1.5. Leaf/stem ratio	88
4.1.6. Efficiency of solar energy conversion	89
4.2. Quality characteristics of sudangrass forage	93
4.2.1. Plant height	93
4.2.2. Stem diameter	96
4.2.3. Blade area/plant	98
4.2.4. Specific leaf weight (SLW)	101
4.2.5. Leaf/stem ratio	102
4.2.6. Efficiency of solar energy conversion	104
5. Interaction effect on quality characteristics	107
5.1. Plant height	107
5.2. Stem diameter	110
5.3. Leaf area/plant	111
5.4. Specific leaf weight (SLW)	113
5.5. Leaf/stem ratio	115
5.6. Efficiency of solar energy conversion (SEC %)	116
6. Chemical composition of cowpea ..	118
6.1. Effect of organic manure	118
6.2. Effect of nitrogen fertilization	124
6.3. Effect of intercropping patterns	129
7. Chemical composition of sudangrass	133
7.1. Effect of organic manure	133
7.2. Effect of nitrogen fertilization	138
7.3. Effect of intercropping patterns	142
8. Interaction effect on chemical composition	146
8.1. Effect of organic manure and nitrogen levels interaction	146
8.2. Effect of organic manure and intercropping patterns interaction	150

Cont.:

Page

8.3. Effect of nitrogen levels and inercropping patterns interaction	152
9. Total chemical yield	155
9.1. Effect of organic manure	155
9.2. Effect of nitrogen fertilization	158
9.3. Effect of intercropping patterns	159
10. Competitive relationships	162
10.1. Effect of intercropping patterns	162
10.1.1. On Aggressivity	162
10.1.2. On Relative Crowding Coefficient	164
10.1.3. On Land Equivalent Ratio	165
10.2. Effect of organic manure and intercropping patterns interaction	166
10.2.1. On Aggressivity	166
10.2.2. On Relative Crowding Coefficient	168
10.2.3. On Land Equivalent Ratio	169
10.3. Effect of nitrogen levels and intercropping patterns interaction	170
10.3.1. On Aggressivity	170
10.3.2. On Relative Crowding Coefficient	172
10.3.3. On Land Equivalent Ratio	174
SUMMARY AND CONCLUSION	176
REFERENCES	186
ARABIC SUMMARY	

LIST OF TABLES

No.	Page
1. Chemical analysis of organic manure (sheep dung)	35
2. Mechanical and chemical analysis of Maryout soil.....	36
3. Effect of organic manure, nitrogen levels and intercropping patterns on fresh yield (Ton/fed.) of cowpea and sudangrass	43
4. Effect of organic manure, nitrogen levels and intercropping patterns on dry yield (Ton/fed.) of cowpea and sudangrass	49
5. Effect of organic manure and nitrogen levels interaction on accumulated fresh and dry yields (Tone/fed.) of cowpea and sudangrass	58
6. Effect of organic manure and intercropping patterns interaction on accumulated fresh and dry yields (Tone/fed.) of cowpea and sudangrass	63
7. Effect of nitrogen levels and intercropping patterns on accumulated fresh and dry yields (Ton/fed.) of cowpea and sudangrass	68
8. Effect of organic manure, nitrogen levels and inter- cropping patterns on botanical composition as fresh yield	76
9. Effect of organic manure, nitrogen levels and inter- cropping patterns on plant height (cm), stem diameter (mm), leaf area (cm ²), S.L.W. (mg/cm ²), leaf/stem ratio and solar conversion (%) at the three cuts of cowpea.	81
10. Effect of organic manure, nitrogen levels and inter- cropping patterns on plant height (cm), stem diameter (mm), leaf area (cm ²), S.L.W. (mg/cm ²), leaf/stem ratio and solar conversion (%) at the three cuts of sudangrass	94
11. Statistical significance and interactions effect between (OM x N), (OM x In. Crop.) and (N x In. Crop.) on plant height (cm), stem diameter (mm), leaf area (cm ²), specific leaf weight (mg/cm ²), leaf/stem ratio (%) and solar conversion (%) of cowpea and sudangrass	108
12. Effect of organic manure, nitrogen levels and inter- cropping patterns on crude protein (%), total carbo- hydrates (%), crude fiber (%) and ash (%) of cowpea..	119

Cont.:

No.	Page
13. Effect of organic manure, nitrogen levels and intercropping patterns on crude protein (kg/fed.), total carbohydrates (kg/fed.), crude fiber (kg/fed.) and ash yields (kg/fed.) of cowpea	121
14. Effect of organic manure, nitrogen levels and intercropping patterns on crude protein (%), total carbohydrates (%), crude fiber(%) and ash(%) of sudangrass.	134
15. Effect of organic manure, nitrogen levels and intercropping patterns on crude protein (kg/fed.), total carbohydrates (kg/fed.), crude fiber (kg/fed.) and ash yields (kg/fed.) of sudangrass	136
16. Statistical significance of interaction effects between (OM x N), (OM x Int. Crop.) and (N x Int. Crop.) on chemical composition of cowpea and sudangrass plants.	147
17. Effect of organic manure, nitrogen levels and intercropping patterns on crude protein, total carbohydrates, crude fiber and ash accumulated yields (kg/fed.) of cowpea and sudangrass.....	156
18. Effect of intercropping patterns on competitive relationships	163
19. Effect of organic manure and intercropping patterns interaction on competitive relationships	167
20. Effect of nitrogen fertilization and intercropping patterns interaction on competitive relationships ..	171

LIST OF FIGURES

No.	Page
1. Effect of organic manure and nitrogen levels interaction on accumulated fresh and dry forage yields (Ton/fed.) of cowpea, sudangrass and their mixture	59
2. Effect of organic manure and intercropping patterns interaction on accumulated fresh and dry forage yields (Ton/fed.) of cowpea, sudangrass and their mixture ...	64
3. Effect of nitrogen levels and intercropping patterns interaction on accumulated fresh forage yield (Ton/fed.) of cowpea, sudangrass and their mixture	69
4. Effect of nitrogen levels and intercropping patterns interaction on accumulated dry forage yield (Ton/fed.) of cowpea, sudangrass and their mixture	73

INTRODUCTION

INTRODUCTION

To increase the production of forage crops in the summer season to face the animal feed needs no more evidence. However, such increase is more pronounced in the newly reclaimed areas, such as that at Maryout, where the soil is calcareous. Sudangrass thrives well in such conditions where it tolerates the unfavourable physical and chemical soil properties, water stress and dry conditions. One of the most promising agronomic practices to increase the production per unit area of land is to cultivate forage crops in mixtures, also to obtain a balanced nutritive forage to feed animals. Cowpea is considered one of the most promising crops that may be intercropped with sudangrass for better quality and quantity of forage yield.

During decomposition of organic manures, humic acid is formed. It acts as a source of macro and micro-nutrients and also as a soil conditioner, so the productivity of calcareous soil may be improved.

However, this work was conducted to study the effect of organic manure, nitrogen fertilization and different patterns of intercropping cowpea and sudangrass plants under calcareous soil conditions aiming to obtain a high yield of forage quality of the mixture to cover the needs for the summer

fodder plants. Due consideration was given to elucidate the competitive relationship between the intercropped sudangrass and cowpea and the botanical composition of the sward at different cuttings. Also, the efficiency of the mixtures in solar energy conversion to dry matter was considered.