

UNIVERSITI PUTRA MALAYSIA

EFFECTS OF NITROGEN FERTILIZATION LEVELS ON THE STRAW NUTRITIVE QUALITY OF MR 211 AND MR 219 RICE VARIETIES

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By

HOLLENA ANAK NORI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirement for the Degree of Master of Science

July 2005



DEDICATION

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Dedicated to my family and friends for their understanding and inspiration



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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July 2005

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Rice straw has been used as ruminant feed in many Asean countries although it is regarded as poor quality feed due to its low protein concentration and digestibility. It has been reported that the nutritive quality of rice straw varies among different varieties and is affected by environmental condition that determines its growth pattern. In view of the reports on the environmental effect on straw quality, this study was designed to evaluate the nutritive quality of rice straw with increasing application of nitrogen fertilizer.

Samples of rice straw from two varieties, MR 211 and MR 219 which were grown under five levels of nitrogen fertilizer (0, 120, 160, 200 and 240 kg N/ha) were harvested and analyzed for chemical composition and digestibility. The results showed that the straw nutritive quality was improved with nitrogen application.



Increases in the level of nitrogen fertilization were found to increase the straw crude protein significantly. The maximum nitrogen level at 240 kg N/ha was found to produce crude protein of 8.45%, which is above the level required for ruminant feed. The straw cell wall (NDF) and fiber (ADF) fraction were found to decrease significantly with nitrogen application. The organic matter digestibility was slightly lowered with increasing nitrogen level. The concentration of hemicellulose, cellulose, lignin (ADL), silica, organic matter, ash and the dry matter digestibility were not affected by the nitrogen fertilization level. In the agronomic characteristics and yield components, the level of nitrogen was shown to increase the tiller numbers, stem height, maturity, number of spikelets per panicle, total spikelets per square meter, grain and straw yield and total yield.

There were significant varietal differences in the concentration of cell wall (NDF), hemicellulose, cellulose, lignin (ADL) and silica in rice straw, where MR 219 had higher cell wall (NDF), hemicellulose and cellulose concentration where as MR 211 had higher amount of lignin (ADL) and silica in the straw. In the agronomic characteristics, MR 219 had higher number of tillers per plant, total panicles per square meter, total spikelets per square meter, grain yield, total yield and grain: straw ratio where as MR 211 had shorter stem height, maturity period and higher leaf: stem ratio. Both varieties were shown to produce straw with improved nutritive quality. In comparison between the two varieties, MR 219 is superior to MR 211 in view of its higher grain yield and grain: straw ratio.



The grain and straw yield were positively correlated with the straw crude protein and digestibility and negatively correlated with the cell wall (NDF) and fiber (ADF) fraction.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KESAN KADAR PEMBAJAAN NITROGEN KE ATAS KUALITI PEMAKANAN PADA JERAMI PADI VARIETI MR 211 DAN MR 219

Oleh

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Jerami padi telah digunakan sebagai makanan ruminan di kebanyakan negara Asean meskipun ia dianggap sebagai makanan berkualiti rendah disebabkan oleh kandungan protein serta kadar pencernaannya yang rendah. Terdapat laporan mengatakan bahawa kualiti pemakanan pada jerami padi adalah berbeza mengikut varieti dan dipengaruhi oleh faktor persekitaran yang mempengaruhi pertumbuhannya. Memandangkan terdapat laporan mengenai kesan persekitaran ke atas kualiti jerami, kajian ini dilakukan untuk menilai kualiti pemakanan pada jerami padi dengan penggunaan baja nitrogen yang tinggi.



Sampel jerami padi daripada dua varieti, MR 211 dan MR 219 yang ditanam di bawah lima kadar pembajaan nitrogen (0, 120, 160, 200 dan 240 kg N/ha) telah dituai dan dianalisis untuk kandungan kimia dan pencernaan. Keputusan menunjukkan bahawa kualiti pemakanan pada jerami telah bertambah baik dengan pembajaan nitrogen.

Peningkatan penggunaan baja nitrogen didapati telah meningkatkan kandungan protein kasar di dalam jerami. Penggunaan baja nitrogen pada kadar maksimum 240 kg N/ha didapati menghasilkan protein kasar sebanyak 8.45%, iaitu memenuhi keperluan untuk makanan ruminan. Kandungan sel dinding (NDF) dan serat (ADF) didapati menurun serta kadar pencernaan bahan organik menurun sedikit dengan penggunan baja nitrogen. Kandungan hemiselulosa, selulosa, lignin (ADL), silika, bahan organik, abu dan kadar pencernaan bahan kering didapati tidak dipengaruhi oleh kadar pembajaan nitrogen. Dalam ciri agronomi serta komponen hasil, kadar pembajaan nitrogen telah meningkatkan bilangan daun, ketinggian batang, umur matang, bilangan biji setangkai, jumlah biji semeter persegi, hasil padi dan jerami serta hasil keseluruhan.

Terdapat perbezaan yang signifikan di antara varieti di dalam kandungan sel dinding (NDF), hemiselulosa, selulosa, lignin (ADL) dan silika, di mana MR 219 mempunyai kandungan sel dinding (NDF), hemiselulosa dan selulosa yang lebih tinggi manakala MR 211 mempunyai kandungan lignin (ADL) dan silika yang lebih tinggi. Dalam ciri-ciri agronomi, MR 219 mempunyai bilangan daun sepokok, jumlah tangkai semeter persegi, jumlah biji semeter persegi, hasil padi, hasil keseluruhan dan nisbah padi: jerami yang lebih tinggi manakala MR 211 mempunyai batang lebih pendek, umur matang yang semeter persegi padi batang lebih pendek, umur matang yang semeter persegi padi batang lebih pendek, umur matang yang semeter persegi padi batang lebih pendek, umur matang yang semeter pendek.



singkat serta nisbah daun: batang yang lebih tinggi. Kedua-dua varieti didapati menghasilkan jerami dengan kualiti pemakanan yang lebih baik. Dalam perbandingan di antara kedua-dua varieti, MR 219 adalah lebih baik berbanding MR 211 kerana mempunyai hasil padi dan nisbah padi: jerami yang lebih tinggi.

Hasil padi dan jerami didapati berkorelasi secara positif dengan kandungan protein kasar dan kadar pencernaan jerami serta berkorelasi secara negatif dengan kandungan sel dinding (NDF) dan serat (ADF).



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TABLE OF CONTENTS

DEDICATION	ii
ABSTRACT	iii
ABSTRAK	vi
ACKNOWLEDGEMENTS	ix
APPROVAL	х
DECLARATION	xii
LIST OF TABLES	xvi
LIST OF FIGURES	xviii
LIST OF ABBREVIATIONS	xxi

CHAPTER

1	INT	RODUC	TION	1
2	LITI	ERATU	RE REVIEW	5
	2.1	The Issu	ue of Rice Straw Burning	5
	2.2	Chemic	al Composition and Digestibility of Rice Straw	6
	2.3	Problem	ns in Using Rice Straw as Ruminant Feed	9
	2.4	Varietal	Differences in the Chemical Composition and Digestibility	11
		of Rice	Straw	
	2.5	Impact	of Nitrogen Fertilizer Application on the Chemical	15
		Compos	sition and Digestibility of Rice Straw	
	2.6	Other F	actors Affecting the Chemical Composition and Digestibility	18
		of Rice	Straw	
		2.6.1	Season	19
		2.6.2	Location	21
		2.6.3	Weather	23
		2.6.4	Maturity	23
		2.6.5	Botanical Fraction	23
		2.6.6	Cultivation Practice	25
		2.6.7	Soil Condition	25
		2.6.8	Harvesting Time	26
		2.6.9	Cutting Height	26
		2.6.10	Storage	28
		2.6.11	Baling Time	29
	2.7	Direct S	Seeding Rice Cultivation	30
	2.8	The Fu	nctions of Nitrogen in Higher Plant	32
	2.9	Nitroge	n Fertilizer and Soil Fertility	33
	2.10	Impact	of Nitrogen Nutrition on Rice Growth and Yield	35
	2.11	Charact	teristics of a High Yielding Rice Variety	41
	2.12	Rice Va	ariety MR 211	43
	2.13	Rice Va	ariety MR 219	44



3	MAT	FERIAL	S AND METHODS	45
	3.1	Experim	nent Location	45
	3.2	Treatme	nts	45
	3.3	Establis	hment of Rice	46
	3.4	Fertilize	r Application	47
	3.5	Pest Cor	ntrol	48
	3.6	Soil San	npling	48
	3.7	Soil Che	emical Analysis	49
		3.7.1	Soil pH _w	49
		3.7.2	Cation Exchange Capacity (CEC)	49
		3.7.3	Exchangeable Cations (Na, K, Ca, Mg)	50
			3.3.3.1 Determination of Na and K cation	50
			3.3.3.2 Determination of Ca and Mg cation	50
		3.7.4	Organic Matter	50
		3.7.5	Total Nitrogen	51
		3.7.6	Available Phosphorus	51
	3.8	Vegetati	ive Development Parameter	52
		3.8.1	Plant height	52
		3.8.2	Number of tillers per plant	52
		3.8.3	Relative chlorophyll content	53
	3.9	Reprodu	uctive Development Parameter	53
		3.9.1	Stem height	53
		3.9.2	Days to flowering	54
		3.9.3	Number of panicles per square meter	54
		3.9.4	Panicle length	55
		3.9.5	Number of spikelets per panicle	56
	3.10	Ripenin	g Development Parameter	56
		3.10.1	Days to grain maturity	56
	3.11	Harvest	and Sample Preparation	56
	3.12	Yield C	omponents	57
		3.12.1	Grain yield	57
		3.12.2	Straw yield	57
		3.12.3	Total biomass yield and grain to straw ratio	58
	3.13	Leaf to	Stem Ratio	58
	3.14	Chemic	al Analysis	58
		3.14.1	Crude protein	59
		3.14.2	Neutral detergent fiber (NDF)	59
		3.14.3	Acid detergent fiber (ADF)	61
		3.14.4	Acid detergent lignin (ADL)	61
		3.14.5	Ash and organic matter	62
		3.14.6	Silica	63
		3.14.7	Hemicellulose and cellulose	63
	3.15	in vitro	True Digestibility and in vitro Gas Production	64
	3.16	5 Statistic	cal Analysis	67
			-	



4	RES	ULTS		68
	4.1	Chemica	al Composition	68
		4.1.1	Crude Protein	68
		4.1.2	Neutral Detergent Fiber (NDF)	71
		4.1.3	Acid Detergent Fiber (ADF)	75
		4.1.4	Acid Detergent Lignin (ADL)	77
		4.1.5	Hemicellulose	79
		4.1.6	Cellulose	82
		4.1.7	Ash	83
		4.1.8	Silica	83
		4.1.9	Organic Matter	84
		4.1.10	In Vitro True Dry Matter Digestibility (IVTDMD)	85
		4.1.11	In Vitro True Organic Matter Digestibility (IVTOMD)	86
		4.1.12	In Vitro Gas Production	88
	4.2	Agrono	mic Characteristics	89
		4.2.1	Plant Height	89
		4.2.2	Number of Tillers	90
		4.2.3	Days to Flowering	92
		4.2.4	Stem Height at Panicle Emergence	92
		4.2.5	Relative Chlorophyll Content	94
		4.2.6	Number of Spikelets per Panicle	95
		4.2.7	Filled Spikelets Percentage	96
		4.2.8	Panicle Height	97
		4.2.9	Number of Panicles per Square Meter	98
		4.2.10	Number of Spikelets per Square Meter	99
		4.2.11	Days to Grain Maturity	101
		4.2.12	Leaf to Stem Ratio	103
		4.2.13	Leaf Proportion	105
		4.2.14	Grain Yield	107
		4.2.15	Straw Yield	109
		4.2.16	Total Biomass Yield above Ground	111
		4.2.17	Grain to Straw Ratio	113
	4.3	Correla	tion Analysis	115
	4.4	Soil Ch	emical Properties	118
5	DIS	CUSSIC)N	119
	5.1	Chemic	cal Composition	119
	5.2	Agrono	mic Characteristics	127
	5.3	Correla	tion between the Agronomic Characteristics and	132
		Straw N	Nutritive Value	
6	CO	NCLUSI	ION	135
R	EFEF	RENCES		138
APPENDICES 12			151	
B	BIODATA OF THE AUTHOR 158			



LIST OF TABLES

Table		Page
2.1	Agronomic characteristics of four rice straw varieties and the proportion of their botanical fractions in whole straw	12
2.2	Chemical composition (% DM) and in vitro DM digestibility (%IVD) of botanical fractions of four rice straw varieties	13
2.3	Effects of variety, level of nitrogen fertilization and season on the crude protein concentration of rice straw (values are % of DM)	16
2.4	Influence of season on the chemical composition and IVD (% in dry matter) of whole straw of two rice varieties	20
2.5	Influences of location on the relative proportion of botanical fractions (%) of two rice straw varieties	21
2.6	Influence of location on the chemical composition and IVD (% in dry matter) of whole straw of two rice varieties	22
2.7	Chemical composition and IVD (% in dry matter) of botanical fractions of two varieties of rice straw	24
2.8	Chemical composition and <i>in vitro</i> dry matter digestibility of wheat straw by soil type	26
2.9	The effects of storage on chemical composition of rice straw due to sunlight and rain	28
2.10	Effect of nitrogen addition on dry matter production and nitrogen uptake by rice	40
3.1	Levels of nitrogen (urea fertilizer) application	46
3.2	Pesticides used to control pest infestation	48
4.1	In vitro gas production (mL/200 mg dry matter) of rice straw under five levels of nitrogen fertilization	88
4.2	Correlation between agronomic characteristics and straw nutritive value	115
4.3	Correlation between yield and yield components	116
4.4	Correlation between straw chemical composition and digestibility	117

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4.5 Soil chemical properties

118



LIST OF FIGURES

Figur	e	Page
2.1	The effects of nitrogen fertilization rate on the protein concentration of eight rice straw varieties in California	17
2.2	The effects of nitrogen fertilization rate on the protein concentration (% of DM) of Akita straw variety	17
2.3	The effects of nitrogen fertilization rate on the ADF concentration (% of DM) in rice straw	18
2.4	Straw yield as affected by cutting height	27
2.5	The effects of straw baling time on the straw digestibility (ADF content)	29
3.1	Experimental unit	47
3.2	Plant height measurements	52
3.3	Chlorophyll measurement	53
3.4	Stem length measurements	54
3.5	Recording number of panicles per square meter using quadrat	55
3.6	Panicle length measurements	55
3.7	NDF using Fibercap System	60
3.8	Incubated syringes in water bath	64
4.1	Effects of nitrogen fertilization on the crude protein	68
4.2	Effects of nitrogen fertilization level on the neutral detergent fiber (NDF)	71
4.3	Varietal differences in the Neutral Detergent Fiber (NDF)	73
4.4	Interaction between the nitrogen level and variety in the leaf NDF	73
4.5	Effects of nitrogen fertilization level on the acid detergent fiber (ADF)	75
4.6	Varietal differences in the acid detergent lignin (ADL)	77

4.7	Interaction between the nitrogen level and variety in the stem ADL	78
4.8	Varietal differences in the hemicellulose	79
4.9	Interaction between the nitrogen level and variety in the leaf hemicellulose	80
4.10	Interaction between the nitrogen level and variety in the whole straw hemicellulose	80
4.11	Varietal differences in the cellulose	82
4.12	Varietal differences in the silica	83
4.13	Effects of nitrogen fertilization level on the <i>in vitro</i> true dry matter digestibility (IVTDMD)	85
4.14	Effects of nitrogen fertilization level on the <i>in vitro</i> true organic matter digestibility (IVTOMD)	86
4.15	Effects of nitrogen fertilization level on the plant height	89
4.16	Effects of nitrogen fertilization level on the number of tillers per plant	90
4.17	Varietal differences in the number of tillers per plant	91
4.18	Effects of nitrogen fertilization level on the stem height	92
4.19	Varietal differences in the stem height	93
4.20	Effects of nitrogen fertilization on the relative chlorophyll content	94
4.21	Effects of nitrogen fertilization on the number of spikelets per panicle	95
4.22	Effects of nitrogen fertilization on the filled spikelets percentage	96
4.23	Effects of nitrogen fertilization level on the panicle height	97
4.24	Effects of varieties on the number of panicles per square meter	98
4.25	Effects of nitrogen fertilization level on the number of spikelets per square meter	99
4.26	Varietal differences in the number of spikelets per square meter	100
4.27	Effects of nitrogen fertilization level on the days to grain maturity	101



4.28	Varietal differences in the days to grain maturity	102
4.29	Effects of nitrogen fertilization level on the leaf to stem ratio	103
4.30	Varietal differences in the leaf to stem ratio	104
4.31	Effects of nitrogen fertilization level on the leaf proportion	105
4.32	Varietal differences in the leaf proportion	106
4.33	Effects of nitrogen fertilization level on the grain yield	107
4.34	Varietal differences in the grain yield	108
4.35	Effects of nitrogen fertilization level on the straw yield	109
4.36	Interaction between the nitrogen level and variety in the straw yield	110
4.37	Effects of nitrogen fertilization level on the total biomass yield above ground	111
4.38	Varietal differences in the total biomass yield above ground	112
4.39	Interaction between the nitrogen level and variety in the total biomass yield	112
4.40	Effects of nitrogen fertilization on the grain to straw ratio	113
4.41	Varietal differences in the grain to straw ratio	114



LIST OF ABBREVIATIONS

ADF	Acid Detergent Fiber
ADL	Acid Detergent Lignin
ADS	Acid Detergent Solution
ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
ATP	Adenosine Triphosphate
CaCl ₂ .2H ₂ O	Calcium Chloride
CEC	Cation Exchange Capacity
CH ₄	Methane
C/N	Carbon to Nitrogen Ratio
CoCl ₂ .6H ₂ O	Cobalt Chloride
CO(NH ₂) ₂	Urea
СР	Crude Protein
CRD	Completely Randomized Design
CTAB	Cetyl trimethylammonium bromide
C.V.	Coefficient of Variance
DAS	Days After Sowing
D.F.	Degrees of Freedom
DM	Dry Matter
DMI	Dry Matter Intake
DNA	Deoxyribonucleic acid



EDTA	Disodium Ethylenediaminetetraacetate
et al.	and friends
FeCl ₂ .6H ₂ O	Iron Chloride
HCl	Hydrochloric Acid
H ₃ PO ₄	Phosphoric Acid
H ₂ SO ₄	Sulphuric Acid
IVD	In Vitro Digestibility
IVDMD	In Vitro Dry Matter Digestibility
IVOMD	In Vitro Organic Matter Digestibility
IVTDMD	In Vitro True Dry Matter Digestibility
IVTOMD	In Vitro True Organic Matter Digestibility
$K_2Cr_2O_7$	Potassium Dichromate
KH ₂ PO ₄	Potassium Dihydrogen Phosphate
K ₂ O	Dipotassium Oxide
K ₂ SO ₄	Potassium Sulphate
LAI	Leaf Area index
L.S.D.	Least Significant Difference
MARDI	Malaysian Agriculture Research and Development Institute
MgSO ₄ .7H ₂ O	Magnesium Sulphate
MnCl ₂ .4H ₂ O	Manganese Chloride
МОР	Muriate of Potash
Ν	Normality
NaHCO ₃	Sodium Hydrogen Carbonate

Na ₂ HPO ₄	Disodium Hydrogen Phosphate
NaOH	Sodium Hydroxide
Na ₂ S.7H ₂ O	Sodium Sulphite
$Na_2S_2O_3$	Sodium Thiosulphate
NDF	Neutral Detergent Fiber
NDS	Neutral Detergent Solution
NH ₃	Ammonia
NH^{+}_{4}	Ammonium ion
NH4F	Ammonium Flouride
(NH ₄)HCO ₃	Ammonium Hydrogen Carbonate
NH₄OAc	Ammonium Acetate
NO ₂	Nitrogen dioxide
PE	Polyethylene
P_2O_5	Diphosphate Pentaoxide
RNA	Ribonucleic Acid
SAS	Statistical Analysis Software
S.D.	Standard Deviation
S.E.	Standard Error
sp.	Species
SPAD	Specific Photosynthesis Analyzer Detector
TSP	Triple Super Phosphate



CHAPTER 1

INTRODUCTION

Rice is the staple food for Malaysians. As population increases, there is need to increase the rice grain production to enhance food security. The target of the Ministry of Agriculture and Agro-based Industry Malaysia is to increase the rice grain yield from current average yield of 4.5 t/ha to 10 t/ha (MOA, 2004a). Among the steps that have been taken to achieve this target is the application of high levels of nitrogen fertilizer. Farmers are currently applying more than the recommended rate of 170 kg N/ha as they believe that higher nitrogen levels are essential in maximizing grain yields (Alias and Manaf, 1993).

In Malaysia, the rice breeding research has been focusing on improving the agronomic characteristics such as grain yield and quality. Research has generally concentrated on the importance of nitrogen in increasing the grain yield and the effects of nitrogen on the straw yield and quality have not been investigated.

The 684 000 hectares of rice fields in Malaysia produced 1.3 million tonnes of rice straw annually (MOA, 2004b). The burning of rice straw and stubble in Malaysian rice field still remain as cultural and current practice of its disposal. Since large amount of straw produced is disposed by burning which is not only wasting resources but also causing

