Nutritional Characteristics of *Brachiaria ruziziensis* (Germain & Evrard) Subjected to Different Doses of Gamma Rays

A. I. Hoka
Kenya Agricultural Research and Livestock Organization, Kenya

M. Gicheru
Kenyatta University, Kenya

S. Otieno
Kenyatta University, Kenya

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HokaAI*., Gicheru†, M., and Otieno†, S.

* KALR0-National Beef Research Institute, P.O. Box 3840, Nakuru, Kenya. [2] Department of Zoological Sciences, Kenyatta University, P. O. Box 43844, Nairobi, Kenya, Email: **indetie2001@yahoo.com** †
Key Words: gamma rays, Brachiaria ,mutant lines

Abstract

Appropriate methods of mutation induction are of high importance in pastures for increased genetic variability and improved forage performance. The objective of this research was to improve agronomic and nutritive performance of mutant lines through induced mutagenesis to seeds of a local landrace *Brachiaria ruziziensis*. The seeds were irradiated with 0, 10, 20, 30, and 40Gy doses of gamma radiation from Cobalt 60 (^{60}Co). Treatments were; KE 0Gy, KE 10Gy, KE 20Gy, KE 30Gy, and KE 40Gy resulting into M1 seeds. The seeds were planted in the greenhouse in germination pots then transplanted to the field. Seeds of M6 plants (M7 seeds) were used to establish field experiment in a completely randomized block design, with three replications. Parameters measured included; tillering, leaf-stem ratio, dry matter, mineralogy, digestibility, and crude protein. Data collected was analyzed using Genstat version 18 software. Growth parameters that were affected by radiation included tillering and days to 50% flowering. Radiation increased neutral detergent fiber (NDF), acid detergent fiber (ADF), and crude protein (CP). NDF had high positive correlation with ADF, CP had high positive correlation with leaf length. Results from agronomic performance**,** nutrient profile**s** indicated that the mutant lines differed from their parents. The mutant lines could be selected, multiplied and used in feeding trials to determine reproductive performance of dairy cattle fed on the mutant lines. Future studies should focus on total mixed ration formulation using the mutant lines, designed feeding trials, fractionation of amino and fatty acids from the lines for incorporation in poor forages and national performance trials of mutant lines with an aim of forage variety release. Application of nuclear technology to other grasses would lead to increased biomass and improved nutrition for increased animal productivity leading to food and nutrition security.

IntroductionThe effect of gamma radiation in improving plant performance has been shown to be highly related to the level of doses used (Respati *et al*. 2018). However, information is scanty on the effect of gamma radiation dose on the local Brachiaria species in Kenya. The objective of this research was therefore to determine effect of gamma irradiation of local *Brachiaria ruziziensis* **(**Germain & Evrard) seeds on the grass performance and nutritional quality.

Methods and Study Site

A total of 1,000 landrace (KE) seeds of *Brachiaria ruziziensis* were put in each of 6 pre-labeled petri dishes (KE 0, KE 10, KE 20, KE 30, and KE 40). The seeds were irradiated with 0, 10, 20, 30, and 40 Grey (Gy) doses of gamma radiation from Cobalt 60 (^{60}Co).

Field trials were conducted at KALRO -Lanet (0° 27' 09' S and 390 38’ 45’ E, at an elevation of 1600 meters above sea level. The site is located in Nakuru County, Kenya.

Mutant seeds (M1 seeds) were grown in germination trays in the green house for one month during which time germination rate was recorded.

The experiment was laid out as a complete randomized block design (RCBD) with three replications. The seeds were planted into holes at a depth of 3.0cm at a spacing of 60 cm x 30cm. The Brachiaria grass was top dressed with 67.5 kg/ha of N (CAN (27% N) when the crop was 60 cm tall. Agronomic performance was recorded at booting (Rana and Suresh, 2014). The grass was cut at 2.0 cm above ground at booting stage and used to determine leaf to stem ratio, nutritive values, and herbage yield (kg/ha). In-vitro digestibility was performed using method described by Tilley and Terry (1963).

Dry matter (DM, g/kg) contents were determined according to AOAC (1990) method while organic matter (OM) and ash were determined according to AOAC (2006a) method. Crude protein (CP) content (g/kg DM) was calculated as 6.25 x N (Kjeldahl nitrogen) content in the feed. The N content was determined according to AOAC (2006b) method. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to Van Soest *et al*. (1991). Minerals were analysed using a technique described by Okalebo et al (2002). Amino acid and fatty acids were analyzed using a technique described by Tie-xin and Wu Hong (2008).

Data was analysed using Genstat version 18 software

Results

Germination in the green house and field establishment

Percent germination significantly ($P<0.05$) decreased with increased gamma ray exposure. Performance in field was as indicated in the table below (Table 1).

Table 1: Effect of gamma irradiation on agronomic performance of *Brachiaria ruziziensis*

Treatment	Establishment	Tillers	Day_50	SER	IL	LER	LL	LSR	Chlorophyll	PH
Control	100a	15.7d	179a	0.25bc	6.5	0.15b	17.8c	0.25c	46.4a	127.3ab
10Gy	100a	21.0d	160b	0.32ab	6.6	0.18b	28.3ab	0.27bc	41.8ab	138.7a
20Gy	100a	24.0c	154b	0.37a	5.7	0.17b	31.3a	0.30abc	40.0bc	121.7abc
30Gy	100a	26.7b	154b	0.40a	5.6	0.5a	30.3ab	0.31abc	38.0bc	94.3bc
40Gy	100a	34.0a	150b	0.35a	6.2	0.2b	30.7a	0.36a	35.9c	80.7c
Tukey MSD (α=0.05)	ns	2.2	12.7	0.09	ns	0.3	6.5	0.1	5.3	23.7

Means followed by different letters within a column are significantly different from each other at α=0.05. MSD- Tukey's mean significant difference.

Minerals, protein and sugar content of Brachiaria ruziziensis

Protein increased with the increase in gamma ray exposure. Iron concentration was highest in 30Gy treatment. The highest zinc concentration was in 10Gy exposure. The 20Gy exposure had highest sucrose content (Table 2).

Table 2: Effect of gamma irradiation dose on the mineral and sugar content of *Brachiaria ruziziensis*

Treatment	Crude protein (%)	Zinc (mg kg^{-1})	Sucrose (µg g^{-1})	Iron (ppm)
Control	8.2d	65.4c	7.2d	175.0e
10Gy	8.9c	78.7a	12.2b	185.4d
20Gy	10.6b	73.0b	13.6a	209.8b
30Gy	12.3a	64.6c	9.2c	260.5a
40Gy	12.6a	62.9c	7.6d	193.9c
Tukey MSD (α=0.05)	0.65	3.5	0.43	8.4

Means followed by different letters within a column are significantly different from each other at α=0.05. MSD- Tukey's mean significant difference.

Proximate Analysis and digestibility of Brachiaria ruziziensis mutant lines

The 10Gy treatment had highest levels of nutrient detergent fiber (NDF) and acid detergent fibre (ADF). The CP increased with increasing ^{60}Cobalt exposure.Digestibility coefficients. (OMD) and (DOMD) was significantly ($P<0.05$) higher in the control (Table 3).

Table 3: Effect of gamma irradiation dose on the proximate analysis and digestibility coefficients of Brachiaria ruziziensis mutant lines

Treatment	NDF	ADF	CP	ADL	OMD	DOMD	DMD
Control	56.5b	37.2c	7.7bc	5.6a	32.7a	281.8a	36.7
10Gy	61.7a	44.4a	6.7c	5.7a	21.8d	184.7d	24.2
20Gy	59.8ab	42.9ab	7.5bc	5.3a	26.9bcd	225.5bcd	27.6
30Gy	56.0b	36.3c	8.2b	4.2b	30.1bc	255.0bc	35.4
40Gy	59.8ab	42.0b	8.4a	5.2a	23.4cd	196.8cd	27.7
MSD (α=0.05)	4.1	2.2	0.8	0.6	7.4	22.5	NS

Means followed by different letters within a column are significantly different from each other at α=0.05. MSD- Tukey's mean significant difference.

NDF- Nutrient detergent fiber, ADF- acid detergent fiber, OMD- organic matter digestibility, CP- Crude protein, DMD- dry matter digestibility, DOMD- dry and organic matter digestibility.

Correlation of the nutrient contents to digestibility and agronomic variables

There were high correlations of the variables (Table 4).

Table 4: Correlation of the nutrient contents to digestibility coefficients and agronomic variables

	NDF	ADL	CP	OMD	FATS	DAY_50	SE	LL	LSR	Height	TSW
NDF	1	0.99^{**}	-0.98^{*}	-0.84^{ns}	0.98^{*}	0.95^{ns}	-0.92^{ns}	-0.99^{**}	-0.96^{*}	0.99^{*}	-0.97^{*}
ADL		1	-0.98^{*}	-0.83^{ns}	0.97^{*}	0.94^{ns}	-0.91^{ns}	-0.99^{*}	-0.96^{*}	-0.99^{*}	-0.97^{*}
CP			1	0.93^{ns}	-0.99^{**}	-0.97^{*}	0.97^{*}	0.99^{**}	0.96^{*}	-0.98^{**}	0.99^{**}
OMD				1	-0.94^{ns}	-0.94^{ns}	0.98^{*}	0.90^{ns}	0.90^{ns}	-0.89^{ns}	0.93^{ns}
FATS					1	0.97^{*}	-0.97^{*}	-0.99^{*}	-0.96^{*}	0.99^{**}	-0.99^{**}
DAY_50						1	-0.99^{**}	-0.98^{*}	-0.99^{**}	0.95^{*}	0.95^{*}
SE							1	0.96^{**}	0.97^{**}	-0.95^{ns}	0.95^{*}
LL								1	0.982^{*}	-0.99^{**}	0.98^{*}
LSR									1	-0.95^{ns}	0.94^{ns}
Height										1	-0.99^{**}
TSW											1

*, **- significant at $p<0.05$ and $p< 0.01$ respectively; ns- not significant

NDF-Neutral detergent fiber, ADF- Acid detergent fiber, CP- Crude protein, OMD- Organic matter digestibility, DAY_50- Days to 50% flowering, SE- Shoot elongation, LL- Leaf length, LSR- Leaf-shoot ratio, TSW- Total seed weight

Discussion

Irradiation is affected growth parameters due to modification of plant cells caused by the free radicals (Ashraf *et al*. 2003). Irradiation increased the crude protein and decreased digestibility. The increase in protein could be due to de novo synthesis of stress proteins triggered by metal exposure (Borzouei et al., 2010). These results agreed with the finding of Meire *et al.* (2014). There was positive correlation between the dry matter and the agronomic characteristics of the plant. These findings agreed with the finding of Tudsri *et al*. (2002). The mutant lines should be used as a donor parents in forage breeding program. Studies should focus on designed feeding trials using the mutant lines.

Conclusions

Results indicated that the mutant lines outperformed their parents in agronomic, and some nutritive aspects.

Acknowledgement

The authors acknowledge: Director general KALRO for facilitation of the Study
IAEA for donating equipment and reagents used in the study.

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