*Indian Journal of Animal Sciences* 78 (4): 406–409, April 2008

# Effect of organic and inorganic fertilizer on nutritive value of sorghum fodder in cattle ration

SULTAN SINGH[1], G SURESH[2], S S KUNDU[3] and P S PATHAK[4]

*Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh 284 00 India*

Received: 27 July 2007; Accepted: 17 September 2007

ABSTRACT

Jowar (*Sorghum bicolor* cv. PC–6) grown under organic and inorganic fertilizer agronomic practices was evaluated for its chemical constituents and *IVDMD* in green stage and for *in vivo* evaluation 12 lactating cattle (mean body weight 312±9.18 kg) distributed equally in G1 and G2 groups. They were offered organic and inorganic sorghum hay, respectively, along with 0.5 kg concentrate at each milking to assess their effect on intake, nutrients utilization, milk yield and composition and reproductive performance. CP was relatively more in organic (10.82 and 6.97) than inorganically grown sorghum (8.94 and 6.13%), while the cell wall fractions were 3–3.5 units less in former than later both at green stage and hay, respectively. IVDMD (%) of organic sorghum (green) was 4 units more than inorganically produced sorghum.

DMI (% body weight and g/kg $W^{0.75}$) was comparable in the animals fed organic and inorganically grown sorghum. DM, OM, CP, NDF and cellulose digestibility was nonsignificantly higher in animals fed organic vis-à-vis inorganic sorghum. Hemicellulose digestibility was higher in organic than that in inorganic sorghum fed animals. Milk fat, protein, TSS and SNF contents were identical in animals fed organic and inorganically produced sorghum. Half of the animals fed organic sorghum came into heat while none of the animals fed inorganic sorghum showed the estrus symptoms. These preliminary results indicated that organically grown sorghum has relatively higher nutritive value.

**Key words**: Digestibility, Inorganically grown fodder, Fodder, Milk composition, Nutrients, Organic fodder

Applications of fertilizers affect the composition of plant material (Hopekin *et al.* 1966, Rendig 1988). Positive and negative effects of organic (manure) and inorganic (chemical) fertilizers on nutritional value, sensory quality of produce and animal productivity have been reviewed (Bourn and Prescott 2002). Lanyasunya *et al.* (2006) reported effect of manure and inorganic fertilizer on yield and quality of *Vicia villosa* intercropped with *Sorghum almum* fodder. The ultimate test of the nutritional value of any food or feed/ fodder depends on its ability to support health, growth and reproduction over successive generations of animals or humans. Animal feeding experiments showed improved health (Worthington 1998) and better conception rate (Aehnelt and Hahn 1978, Strem and Olesen 1997) in animals fed organically produced feed. The information of the relative chemical composition of organic and inorganic fodder and feed and its effect on nutrients intake, utilization, milk yield and its composition is anecdotal particularly in Indian context.

Present address: [1]Senior Scientist, [4] Formerly Director.

[2] Senior Scientist, Directorate of Maize Research, Hyderabad, Andhra Pradesh

[3] Principal Scientist, National Dairy Research Institute, Karnal, Haryana 132 001.

## MATERIALS AND METHODS

Sorghum cultivar PC–6 was grown under organic (farm yard manure-FYM as fertilizer) and inorganic (chemical fertilizers) agronomic practices in 1 ha each at the IGFRI Research farm in Kharif–2004. The amount of FYM was applied in single dose at field preparation and chemical fertilizers were applied at sowing and later as top dressing to meet their NPK requirements. Samples harvested at green (41–42% DM) stage were initially dried under shade followed by drying in hot air oven were used for *in vitro* evaluation. On the other hand both types of sorghum were harvested near grain maturity stage and conserved as hay for *in vivo* feeding.

*Animal feeding-cum-digestion trial*

Lactating cattle (12) with mean weight of 312.60±14.21 and 311.75±10.11 kg were distributed equally in G1 and G2 respectively. The animals in G1 and G2 were offered organic and inorganically produced sorghum hay *ad lib.* and 0.5 kg concentrate at each morning and evening milking. The animals were maintained on these diets for more than 3

months. After 60 days of feeding a digestion trial was conducted and samples of feed, residue and faeces were collected for 7 days and after drying samples of individual animal were pooled for further chemical assays.

Milk samples were collected at the end of digestion trial each time in morning and evening for 3 consecutive days and evaluated for its chemical composition and sensory quality traits. Animal were serviced through natural breeding.

*Analytical techniques*

Dried samples of green sorghum, hay, residue and faeces were ground through 2 mm sieve. Crude protein, ash and dry matter contents were estimated as per AOAC (1990). Cell wall fractions, NDF, ADF, cellulose and lignin were determined following the method of Van Soest *et al.* (1991). For i*n-vitro* dry matter digestibility 0.5 g sample of each fraction was placed in triplicate in flasks and incubated in rumen inoculum at 39 °C following 2–stage technique of Tilley and Terry (1963). The rumen liquor as source of inoculum was collected at 0 h (before feeding) from fistulated male buffaloes maintained on wheat straw concentrate diet (70:30) at the Animal Research Farm of Institute. The loss in dry matter of incubated samples after 72 h of incubation was calculated as dry matter digestibility. Eight experts (male and female 4 each) evaluated milk for its colour, odor, consistency and taste. Milk fat was determined by Gerber method while protein by kjeldhal method, respectively. The data were subjected to statistical analysis (Snedecor and Cochran 1968) using computer programme SPSS 10.

## RESULTS AND DISCUSSION

*Chemical composition*

The accumulation of dry matter was relatively low in organic than that in inorganically grown sorghum at green stage (Table 1). Organic sorghum had 2 units more CP and 3–4 units less fibre (NDF, ADF and cellulose) than inorganically produced sorghum at green stage. Lignin contents were 4.31 and 5.81% in organic and inorganic sorghum, respectively. Similarly the organically grown sorghum hay had lower accumulation of fibre contents than inorganically grown sorghum hay (Table 1). The variability in the chemical constituents between organic and inorganic sorghum may be partly attributed to differences in their dry matter contents. Further the application of manure might have improved the water holding capacity of soil resulting in less moisture stress that caused lower dry matter accumulation in organically produced sorghum. Better nutritional make up of organic crops have been reported in cereal crops mainly in terms of minerals, vitamin C and protein quality (Syltie *et al.* 1982, Lund 1991). Low fibre contents (ADF, cellulose and lignin) and more CP in organic sorghum and mixture of sorghum-Vicia reported by Lanyasunya *et al.* (2006) are in agreement of present findings.

Table 1. Chemical composition of organically and inorganically produced sorghum (green and hay)

| Chemical constituents | Green stage | | Hay | |
|---|---|---|---|---|
| | Organic | Inorganic | Organic | Inorganic |
| Dry matter | 40.90 | 42.10 | 71.63 | 67.00 |
| Crude protein | 10.82 | 8.94 | 6.97 | 6.13 |
| NDF | 62.40 | 66.27 | 78.05 | 73.42 |
| ADF | 37.92 | 40.84 | 44.56 | 48.05 |
| Cellulose | 31.14 | 34.20 | 37.21 | 39.20 |
| Hemicellulose | 24.48 | 25.43 | 33.49 | 35.37 |
| Lignin | 4.31 | 5.82 | 5.54 | 6.79 |

*In vitro dry matter digestibility*

*In vitro* dry matter digestibility of organic sorghum was 4 units more than inorganically grown sorghum. Relatively less accumulation of fibre components particularly the ADF and lignin might be responsible for higher degradability of organic sorghum. Chaurasia *et al.* (2006) established that effect of cell wall contents on dry matter degradability of fodder and feeds. Higher DDM% of organically grown sorghum alone and sorghum-vicia mixture than inorganic sorghum and sorghum-vicia -observed by Lanyasunya *et al.* (2006) substantiate the present results.

*Intake and nutrients digestibility*

Feed intake of animals fed organic and inorganically grown sorghum hay was comparable (Table 2). DMI on% body weight and g/kg $W^{0.75}$ was 2.37±0.16 and 99.61±3.94 in organic and 2.35±0.23 and 98.93±7.68 in inorganically produced sorghum hay fed animals, respectively. Dry matter digestibility was 3 units more in organic sorghum hay than

Table 2. Feed intake and nutrients utilization in milch cows fed organically and inorganically produced sorghum

| Attributes | Organic (G1) | Inorganic (G2) |
|---|---|---|
| Initial Mean weight | 312.6.0 | 311.75 |
| Final mean weight | 314.67±16.32 | 310.00±10.32 |
| Intake | | |
| Kg/d | 7.14±0.48 | 7.27±0.17 |
| % Body weight | 2.37±0.16 | 2.35±0.23 |
| g/kg W0.75 | 99.61±3.94 | 98.93±7.68 |
| Nutrients digestibility | | |
| Dry matter | 50.90±1.51 | 47.62±0.83 |
| Organic matter | 53.54±1.40 | 50.14±0.75 |
| Crude protein | 34.50±2.02 | 33.84±2.10 |
| NDF | 48.90±1.50 | 46.71±0.86 |
| ADF | 42.74±1.78 | 41.40±1.10 |
| Cellulose | 56.31±1.60 | 53.08±.040.92 |
| IVDMD | 52.10±1.30 | 48.00±0.57 |
| Hemicellulose* | 60.71±1.11 | 56.38±1.03 |
| IVDMD | 52.10±1.36 | 48.10±0.57 |

*Differ significantly at P<0.05.

inorganically grown sorghum hay fed animals. The digestibility of NDF, ADF and cellulose were statistically comparable in animals fed organic vis-à-vis inorganically produced sorghum hay, while that of hemicellulose was significantly ($P<0.05$) higher in organic than inorganic sorghum hay fed animals. Relatively higher digestibility of cell wall fractions and DM in organic sorghum hay fed animals may be partly due to lower concentration of these constituents in organically produced sorghum. Higher DDM (%) of organic sorghum and mixed crop of sorghum-vicia (Lanyasunya *et al.* 2006) than inorganic agrees with present results.

*Milk composition and sensory quality*

The milk constituents (fat, protein, TSS and SNF) were identical in animals fed organic and inorganically grown sorghum hay (Table 3). The concentration of TSS and SNF was 14.60±0.13 and 9.35±0.13 in milk of animals fed organic compared to 14.30±0.17 and 9.40±0.19% in inorganically produced sorghum hay. No differences in milk composition of organic and inorganic diet fed cattle observed by Bystrom *et al.* (2002) are on the line of present findings. Sensory quality traits of milk, viz. colour, odour, constancy and taste were comparable between organic and inorganic milk (Table 4). Information on the sensory quality of organic vs. inorganically produced milk is limited. Available results on sensory traits of organic plant food are inconsistent and as some reported superior quality (Basker 1992, Vogtmann *et al.* 1993) and others observed no difference (Johansson *et al.* 1999). Sensory evaluation of milk revealed no differences ($P<0.01$) in the taste (sweetness and freshness), odour, flavour or acceptance of neither organic nor inorganic (conventional) samples (Paraskeva *et al.* 2002) supports present observations.

Table 3. Milk composition (%) of animals fed organic and inorganic sorghum hay

| Milk composition | Organic (G1) | Inorganic (G2) |
|---|---|---|
| Fat | 5.24±0.28 | 4.90±0.29 |
| Protein | 3.74±0.26 | 3.47±0.10 |
| TSS | 14.60±0.13 | 14.30±0.17 |
| SNF | 9.35±0.13 | 9.40±0.19 |

Table 4. Sensory quality traits of milk

| Property | Score | Organic | Inorganic |
|---|---|---|---|
| Colour | 25 | 22.94 | 22.47 |
| Odour | 15 | 13.78 | 13.22 |
| Consistency | 10 | 8.47 | 9.31 |
| Taste | 50 | 47.97 | 48.12 |
| Grand total | 100 | 93.16 | 93.12 |

Table 5. Reproductive performance of cows fed organic and inorganic sorghum hay

| Milk composition | Organic (G1) | Inorganic (G2) |
|---|---|---|
| Number of animals | 6 | 6 |
| Conceived | 3 | 0 |
| Conception rate (%) | 50 | 0 |

*Reproductive performance*

The conception rate of animals fed organic sorghum hay was 50%, while inorganic sorghum hay fed animals showed no estrus symptoms (Table 5). The probable reason for this may be more availability of trace minerals and phyto-nutrients from organically grown crops (Worthington 2001, Brandt and Mogaard 2001). Bulls fed compost applied pasture had better sperm quality than pasture treated with NPK fertilizers (Aehnelt and Hahn 1978).

The preliminary results of the present study indicated that organically grown feed and fodder could be more nutritious, more digestible and above all improves the reproductive efficiency of animals. To substantiate these primary findings there is need to evaluate the diverse feed and fodders grown strictly with organic and inorganic fertilizer applications for nutritional traits coupled with their evaluation by conducting long term feeding trials to assess animal production and reproduction performance

## ACKNOWLEDGEMENTS

The authors are thankful to the Director, IGFRI, for providing the necessary facilities, and technical persons namely Sh Ram Kishan and Rashid Ahmed for their assistance in laboratory work.

## REFERENCES

Aehnelt E and Hahn J. 1978. Animal fertility: a possibility for biological quality assay of fodder and feeds. *Biodynamics* **25**: 36–47.

AOAC.1990. *Official Methods of Analysis.* 13th edn. Association of Official Analytical *Chemists*, Washington D C.

Basker D. 1992. Comparison of taste quality between organically and conventionally grown fruist and vegetables. *American Journal of Alternative Agriculture* 7: 129–36.

Bourn D and Prescott J. 2002. A comparison of the nutritional value, sensory qualities and food safety of organically and conventionally produced foods. *Critical Reviews in Food Science and Nutrition* **42** (1): 1–34.

Brandt K and Mogaard J P 2001. Organic agriculture: does it enhance or reduce the nutritional value of plant foods. *Journal of the Science of Food and Agriculture* **81**: 924–31.

Brandt, C.S. and K.C. Beeson. 1951. Influence of organic fertilization on certain nutritive constituents of crops. *Soil Science* **71**: 449–54.

Bystrom S, Jonsson S and Martinsson K 2002. Organic versus conventional dairy farming-Studies from the Ojebyn Project. Development of Agricultural Research for Northern Sweden,

Swedish University of Sweden. UK Organic Research 2002. *Proceedings of the COR Conference*. pp 179–184 (Eds. Powell *et al.*) 26–28 March, 2002.

Chaurasia M, Kundu S S, Singh Sultan and Mishra A. K. 2006. Cornell net carbohydrate and protein system for nutritional evaluation of tree leaves, shrubs and grasses. *Indian Journal of Animal Sciences* **70**: 81–87.

Hopkins H T, Stevenson E H and Harris P L. 1966. Soil factors and food composition. *American Journal of Clinical Nutrition* **18**: 390–5.

Johansson L, Haglund A, Breglund L, Lea P and Risvik E. 1999. Preference for tomatoes affected by sensory attributes and information about growth conditions. *Food Quality Preferences* **10**: 289–98.

Lanyasunya T P, Rong W H, Mukisira E A, Abdulrazak S A and Ayako W O. 2006. Influence of manure and inorganic fertilizer on yield and quality of Vicia villosa intercropped with Sorghum almum in Ol-joro-orok, Kenya. *Livestock Research for Rural Development* **18** (10).

Lund P. 1991. Characterization of alternatively produced milk. *Milchwissenschaft* **46**: 166–9.

Paraskeva M F, Folland F, Brennan C S and Kuri V. 2002. Consumer attitude and perception of available organic milk: a comparison of the Greek and British situation. (Eds) Powell *et al*. UK *Organic Research 2002: Proceedings of the COR Conference*. pp.335–36 26–28th March 2002, Aberystwyth.

Rendig V V. 1988. Soil fertility and plant nutrition effects on nutritional quality of crops. *Crops as Sources of Nutrients for Humans*. (Eds) Welch R M and Gabelman W H. *Proceedings of a Symposium*. 28 November–December 3, 1982. Madison Wisconson. Soil Society of America, 1984, 61–77.

Snedecor G W and Cochran W G. 1968. *Statistical Methods*. 8th edn. Iowa State University Press, Iowa, USA

Syltie P W, Dahnke W C and Harrold R L. 1982. Nutritional value of hard red spring wheat grain protein as influenced by fertilization and cultivar. *Agronomy Journal* 74: 523–6.

Tilley J M A and terry R A. 1963. A two-stage technique for the *in vitro* digestion of forage crops. *Journal of British Grassland Society* **18**: 104–11.

Van Soest P J, Robertson J B and Lewis B A. 1991. Method for dietary fibre, Neutral detergent fibre and non starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* **74**: 3588–97.

Vogtmann H, MatthiesKehres B and Meier Ploeger A. 1993. Enhanced food quality: effects of composts on the quality of plant foods. *Compost Science and Utilization* **1**: 82–100.

Worthington V. 1998. Effect of Agricultural methods on nutritional quality: a comparison of organic with conventional crops. *Alternative Therapies Health Medicine* **4**: 58–69.

Worthington V. 2001. Nutritional quality of organic versus conventional Fruits, Vegetables and Grains. *The Journal of Alternative and Complimentary Medicine* 7 (2): 161–73.