Range Management and Agroforestry 45 (1) : 167-170, 2024
ISSN 0971-2070 (Print); 2249-5231 (Online)
https://doi.org/10.59515/rma.2024.v45.i1.23

Short communication

Productivity and quality of different *rabi* fodder crops under kinnow mandarin based hortipasture system

P.C. Ghasal*, N. Ravisankar, D. Dutta, Amit Nath, S. Malik, A.K. Prusty, P. Kashyap, M. Shamim and A.S. Panwar

ICAR-Indian Institute of Farming Systems Research, Meerut- 250110, India
*Corresponding author e-mail: pcghasal@gmail.com

Received: 5th March, 2023 Accepted: 9th April, 2024

Abstract

A study was conducted for the assessment of productivity and nutritive quality of different *rabi* fodder crops under kinnow mandarin-based horti-pasture system. Among different *rabi* fodder crops, higher green fodder yield was produced by berseem followed by ryegrass and lucerne under partial shade of kinnow mandarin orchard. Green fodder yield of berseem was 12.83, 14.50, 37.23 and 79.17% higher as compared to ryegrass, lucerne, oat and mustard, respectively. Due to diversity in genetic makeup, parameters of analysis vary significantly in different *rabi* fodder crops. Ash content (14.03%), acid insoluble ash content (3.90%), crude fiber content (48.03%) and crude fat content (3.18%) was found highest under berseem, oat, mustard and ryegrass, respectively. Fat content in ryegrass was 2.47, 4.48, 17.67 and 13.25 times higher as compared to mustard, berseem, lucerne and oat, respectively. Crude protein content was highest in lucerne (32.73%) followed by berseem (25.11%). Similarly lucerne was superior fodder crop with respect to N, Zn and Cu concentrations. Though, P, K and Fe concentration in ryegrass fodder was found higher as compared to other fodder crops.

Keywords: Green fodder, Hortipasture system, Kinnow mandarin, Nutrient contents

Due to the increasing pressure of anthropocentric and development activities, the availability of land for fodder is decreasing day by day, resulting in about 4.0% of the total cultivable area is under fodder crops (Kumar *et al.*, 2013). Decreased land availability for fodder production has great pressure of livestock on available, total feed, and fodder. Additionally, more than 85% of farmers in the country are small and marginal having less than 2 ha land holding. Currently, India is facing net deficiency of green fodder, dry fodder and feed by 35.6, 23.4 and 44%, respectively (Roy *et al.*, 2019; Mahanta *et al*., 2020; Singh *et al.*, 2022). By 2030 requirement for green fodder will be 1207 million tonnes and there will be 66% deficit in green fodder and 25% deficit in dry fodder (IGFRI, 2011). The regional level shortage is more critical than the national level as transportation of fodder to long distances is uneconomical. Under the Western Himalayan, Upper Gangetic Plains and, Eastern Plateau and Hilly Zones, green fodder availability is around 60% of the actual requirement. However, 40 to 60% fodder of the requirement is available in trans Gangetic plains and less than 40% availability in the remaining zones. Owing to a shortage of feed and fodder availability along with poor health and management, the productivity of Indian livestock is 20 to 60% lower in comparison to a global average. Feed and fodder contribute to 70 to 75% of the total cost of livestock production, particularly in milch animals (Roy *et al.*, 2019). To maintain the present level of livestock production and its annual growth in population, the deficiency of fodder has to be met either from increasing productivity, utilizing unexploited feed resources, expanding land area, integrating of different systems or through imports (Kumar *et al*., 2023).

Although the opportunity for area expansion under fodder crops is not feasible and yields of forage crops are reaching a plateau, still a great scope exists to increase forage availability through efficient utilization of horticultural and agroforestry based systems through conversion of these areas into hortipasture and silivipasture systems. Out of a total 25.5 mha area under horticulture (increasing with 2.1% annual growth rate), around 10.2 mha is occupied under cultivation of

© *Range Management Society of India*

fruit and plantation crop which is a potential area for the production of green fodder in their inter-row spaces (DACFW, 2018). Partial shade tolerant fodder crops such as guinea grass, signal grass, congo signal grass, berseem, cowpea, sorghum etc., can be easily grown between inter-row space of fruit plants for efficient utilization of land and other resources (Kumar *et al*., 2012). Citrus, mango, guava, litchi, jujube, etc., in north Indian conditions provides a sizable area for the cultivation of perennial as well as seasonal fodder crops without affecting the productivity of orchard plants (Sharma, 2004; Meena *et al*., 2017). The additional forage availability through such systems is likely to reduce grazing pressure and thus have important environmental implications. Area of kinnow mandarin cultivation has increased considerably under irrigated conditions of north-western regions of India due to its wider adaptability to different agro-climatic regions, higher yield potential, better shelf life and excellent juice quality. Inter-cropping of kinnow mandarin orchards with suitable fodder species could be helpful to merge the gap between demand and supply of green fodder in the region for improvement of livestock production and rural economy. Against this backdrop, an experiment was initiated for assessment of the productivity and quality of different *rabi* fodder crops under inter row space of kinnow mandarin-based horti-pasture system.

The field experiment was carried out during *rabi* 2018-19 at Research Farm of ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, India, situated at the latitude of 29°04'38.8'' N and longitude of 77°42'09.9'' E, and altitude of 237 m above mean sea level. The climate of above unit is semi-arid with dry hot summers and cold winters with an average annual rainfall of 747 mm, 80% of which is received through south-west monsoons during July-September. The experiment was laid out in a randomized complete block design with three replications. Five *rabi* fodder crops *viz.* mustard, berseem, lucerne, oat and ryegrass were assessed under inter-row space of 0.18 ha kinnow mandarin based hortipasture module of 0.70 ha integrated farming system model for marginal farmers having 2 livestock (1 buffalo and 1 desi cow). Size of the experimental plot was 100 m^2 strip of inter-row space. Kinnow mandarin plantation was done during 2010-11 at 5 x 5 m row to plant spacing. All the fodder crops were sown by broadcasting method during first fortnight of November. A standard package of practices was followed for the cultivation of different fodder crops.

Fodder yield of different fodder crops was calculated by harvesting fodder of a 2 x 2 m^2 area using quadrate. Fodder was randomly harvested from five places and averaged for fodder yield (q/ha). Berseem (3 times), lucerne (3 times), oat (2 times) and ryegrass (3 times) were harvested multiple times. However, mustard was harvested single time at maximum vegetative growth (50% flowering) stage. Samples collected for the calculation of fodder yield were also used for the investigation of different parameters of proximate analysis. Proximate analysis (ash content, acid insoluble ash, crude fibre, crude fat and crude protein contents) of different *rabi* season fodder crops was done using standard methodology (AOAC, 1970) at ICAR-Central Institute for Research on Cattle, Meerut. For the estimation of crude protein content, the nitrogen content (N) was determined by micro-Kjeldahl method (Bailey, 1967) and the crude protein (CP) was expressed as N x 6.25. Samples used for proximate analysis were also used for analysis of macro and micro mineral nutrient content in different rabi fodder crops. Nitrogen content in samples was analyzed by using Kjeldahl's apparatus and expressed as percentage. The P content was determined by using Vanado-molybdo-phosphoric acid yellow color method (Piper, 1966). The K content was determined by using the flame photometer and was expressed as percentage. The zinc (Zn), copper (Cu), manganese (Mn) and iron (Fe) content were determined using atomic absorption spectrophotometry (AAS).

The experimental data on different parameters recorded during study period were investigated statistically using the F-test, as per the procedure given by Gomez and Gomez (1984). The significant differences between treatments means were compared with the least significant at 5% level of probability.

Significant variation in fodder yield of different *rabi* fodder crops was observed under kinnow based horti-pasture system. Highest green fodder yield was produced by berseem followed by ryegrass and lucerne (Table 1). Green fodder yield of berseem was 12.83, 14.50, 37.23 and 79.17% higher as compared to ryegrass, lucerne, oat and mustard, respectively. Cultivation of mustard, berseem, lucerne, oat and ryegrass under 0.18 ha horti-pasture module could fulfill the green fodder requirement (50 kg/day) of livestock (1 buffalo, 1 native cow and 2 calves) for the period of 65, 116, 101, 80 and 103 days, respectively. It showed the superiority of berseem and ryegrass to perform better under partial shades of kinnow orchard provided resource competition with other species remained minimal (Pang *et al*., 2019a). Poor growth of oat and mustard made these crops unsuitable for cultivation under kinnow orchards. The presence of trees modified light, nutrient and water availability and affected the production of crops (Jose and Dollinger, 2019; Ram *et al*., 2019; Prajapati *et al*., 2022).

Parameters of proximate analysis were significantly varied among different *rabi* fodder crops. Highest ash content was found in berseem (14.03%) followed by lucerne (13%) and lowest in mustard (7.24%). Acid insoluble ash content was found highest under oat (3.90%) followed by ryegrass and lowest in mustard (0.48%). Mustard recorded highest fiber content (48.03%) followed by oat and least

Table 1. Green fodder yield and proximate analysis of different *rabi* fodder crops under horti-pasture system

Fodder crop	Green fodder yield (q/ha)*	Ash (%)	AIA (%)	Crude fiber (%)	Crude fat (%)	Crude protein (%)
Mustard	216	7.24	0.48	48.03	1.30	11.64
Berseem	387	14.03	1.17	34.44	0.71	25.11
Lucerne	338	13.00	1.92	29.01	0.20	32.73
Oat	282	11.28	3.90	34.89	0.24	10.06
Ryegrass	343	12.23	3.03	30.79	3.18	11.38
SEM	6.5	0.155	0.080	1.23	0.02	0.354
CD ($p < 0.05$)	21.4	0.364	0.264	4.06	0.06	1.174

AIA: Acid Insoluble Ash; *10 quintals (q) = 1 ton

Table 2. Mineral nutrient content in different *rabi* fodder crops under horti-pasture system

Fodder crop	N content (%)	P content (%)	K content (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)
Mustard	1.86	0.134	1.26	36.7	2.80	218.5	28.4
Berseem	4.02	0.189	1.40	66.2	5.99	434.3	72.5
Lucerne	5.24	0.184	1.69	80.4	10.03	504.5	57.7
Oat	1.61	0.201	1.62	48.8	2.24	339.4	246.6
Ryegrass	1.82	0.203	3.05	76.2	2.43	602.5	155.3
SEM	0.056	0.005	0.053	1.63	0.085	6.85	2.87
CD ($p < 0.05$)	0.186	0.016	0.175	5.40	0.282	22.70	9.52

under lucerne (29.01%). Higher fat content was found under ryegrass (3.18%) followed by mustard (1.30%) and lowest was with lucerne (0.20%). Fat content in ryegrass was 2.47, 4.48, 17.67 and 13.25 times higher as compared to mustard, berseem, lucerne and oat, respectively. Among the different fodder crops, crude protein content was found to be higher under legume crops. The highest crude protein content was registered under lucerne (32.73%), followed by berseem (25.11%). Higher protein content under berseem and lucerne might be due to its leguminous nature (Ruckle *et al.*, 2017). Variation under different proximate parameters under *rabi* fodder crops might be due genetic makeup of different fodder species (Pezzopane *et al*., 2019; Pang *et al*., 2019b).

Different *rabi* fodder crops differed significantly with respect to mineral nutrient composition (macro- and micro minerals) under kinnow mandarin-based horti-pasture system. Nitrogen content was found highest under lucerne (5.24%) followed by berseem (4.02%) (Table 2). However, phosphorus content was registered maximum under ryegrass (0.203%) and found statistically identical with oat (0.201%). It was noticed that among the macronutrients, nitrogen content was comparatively higher under fodder crops of the Leguminosae family (lucerne and berseem) and phosphorus content in fodder crops of the Gramineae family (oat and ryegrass). Potassium (K) content was found highest under ryegrass (3.05%) followed by lucerne (1.69%) and oat (1.62%). K content in ryegrass was 2.42, 2.18, 1.80 and 1.88 times higher as compared to mustard, berseem, lucerne and oat, respectively. Among different micro-nutrients, zinc content was found highest under lucerne (80.4 ppm) followed by ryegrass. Similarly, copper content was found to be highest under lucerne (10.03 ppm) followed by berseem (5.99 ppm). Iron content was found to be highest under ryegrass (602.5 ppm) and Mn under oat (246.6 ppm). Lucerne was a superior fodder crop with respect to N, Zn and Cu concentrations. However, with respect to P, K and Fe concentration ryegrass fodder was found superior as compared to other fodder crops. The lower concentration of macro and micro-nutrients in mustard fodder makes it an unsuitable crop for livestock feeding as compared other fodder crops. Significant variation in nutrient contents of different legume and grassy fodders under silvopsture systems was also reported by earlier (Pang *et al*., 2019b; Pezzopane *et al*., 2019). Based on this study, it was concluded that legume fodder crops performed better under the partial shade of kinnow mandarin-based hortipature system. Berseem and ryegrass were found promising *rabi* fodder crops to fulfill green fodder requirements with higher yield and nutrient contents under kinnow mandarin-based hortipasture systems for marginal households of the western plain zone of Uttar Pradesh.

Acknowledgment

Authors sincerely acknowledge ICAR-AICRP on Integrated Farming Systems scheme for financial

assistance and ICAR-Central Institute for Research on Cattle, Meerut for sharing laboratory facilities in proximate analysis of fodder samples of this study.

References

AOAC. 1970. *An Official Method of Analysis*. XI edn. Association of Official Analytical Chemists, Washington, DC, USA.

Bailey, R.L.1967. *Techniques in Protein Chemistry*. 2nd edn. Easier Publishing Company, Amsterdam.

DACFW. 2018. *Horticultural Statistics at a Glance.* Horticulture Statistics Division, Department of Agriculture, Cooperation and Farmer's Welfare, Ministry of Agriculture and Farmer's Welfare, Government of India, New Delhi.

Gomez, K.A. and A.A. Gomez. 1984. *Statistical Procedures for Agricultural Research*. 2nd edn. John Wiley & Sons, New York, USA.

IGFRI. 2011. Vision-2030 document. ICAR-Indian Grassland and Fodder Research Institute. Jhansi, India. http://www.igfri.res.in/pdf/Vision-2030.pdf.

Jose, S. and J. Dollinger. 2019. Silvopasture: a sustainable livestock production system. *Agroforestry Systems* 93: 1-9.

Kumar, S., A.K. Shukla and H.V. Singh. 2013. Intercropping of pearl millet + cowpea as rainfed fodder crops with aonla based agri-horti-system. *International Journal of Horticulture* 3: 28-34.

Kumar, S., R.K. Agrawal, A.K. Dixit, A.K Rai, J.B. Singh and S.K. Rai. 2012. *Forage Production Technology for Arable Lands.* Indian Grassland and Fodder Research Institute, Jhansi, India. pp. 1-48.

Kumar, S., P. Singh, U. Devi, K.R. Yathish, P. L. Saujanya, R. Kumar and S.K. Mahanta. 2023. An overview of the current fodder scenario and the potential for improving fodder productivity through genetic interventions in India. *Animal Nutrition and Feed Technology* 23: 631-644.

Mahanta, S. K., S.C. Garcia and M.R. Islam. 2020. Forage based feeding systems of dairy animals: issues, limitations and strategies. *Range Management and Agroforestry* 41: 188-199.

Meena, L.R., R.S. Yadav and S. Kumar. 2017. Enhancing productivity, profitability and soil health through integrated nutrient management in ber-based hortipasture system in Rajasthan. *Range Management and Agroforestry* 30: 100-107.

Pang, K., J.W. Van Sambeek, C.H. Lin, S. Jose and H.E. Garrett. 2019a. Responses of legumes and grasses to non-, moderate, and dense shade in Missouri, USA. I. Forage yield and its species-level plasticity. *Agroforestry Systems* 93: 11-24. https://doi.org/10.1007/s10457-017-0067-8.

Pang, K., J.W. Van Sambeek, N.E. Navarrete-Tindall, C.H. Lin, S. Jose and H.E. Garrett. 2019b. Responses of legumes and grasses to non-moderate, and dense shade in Missouri, USA. II. Forage quality and its species-level plasticity. *Agroforestry Systems*. 93: 25-38. https://doi.org/10.1007/s10457-017-0068-7.

Pezzopane, J.R.M., A.C.C. Bernardi, C. Bosi, P.P.A. Oliveira, M.H. Marconato, A. de Faria Pedroso and S.N. Esteves. 2019. Forage productivity and nutritive value during pasture renovation in integrated systems. *Agroforestry Systems.* https://doi.org/10.1007/s10457-017-0149-7.

Piper, C.S. 1966. *Soil and Plant Analysis*. Hans Publishers, Mumbai, Maharashtra, India. pp. 250-251.

Prajapati, D.R., N.S. Thakur, R.P. Gunaga, V.R. Patel, L. Mahatma and D.P. Patel. 2022. Melia dubia tree spacing influence growth, yield and proximate principles of *sorghum bicolor* x *Sorghum bicolor* var. sudanese and soil microbial status. *Range Management and Agroforestry* 43: 283-291.

Ram, S.N., R.V. Kumar and A.K. Shukla. 2019. Influence of shrubs and tree densities on three-tier silvopasture components in semi-arid rainfed conditions. *Range Management and Agroforestry* 40: 104-108.

Roy, A. K., R.K. Agrawal, N.R. Bhardwaj, A.K. Mishra and S.K. Mahanta. 2019. Revisiting national forage demand and availability scenario. In: A. K. Roy, R. K. Agrawal and N. R. Bhardwaj (eds). *Indian Fodder Scenario: Redefining State Wise Status*. ICAR-AICRP on Forage Crops and Utilization, Jhansi, India. pp. 1-21.

Ruckle M., M. Meier, L. Frey, S. Eicke, R. Kölliker, S. Zeeman and B. Studer. 2017. Diurnal leaf starch content: an orphan trait in forage legumes. *Agronomy* 7: 1-15

Sharma, S.K. 2004. Hortipastoral based land use systems for enhancing productivity of degraded lands under rainfed and partially irrigated conditions. *Uganda Journal of Agricultural Sciences* 9: 320-325.

Singh, D.N., J.S. Bohra, V. Tyagi, T. Singh, T.R. Banjara and G. Gupta. 2022. A review of India's fodder production status and opportunities. *Grass and Forage Science* 77: 1-10.