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FORAGE AND GRAIN PRODUCTIVITY, QUALITY AND ECONOMICS OF SOME MAIZE (*Zea mays* L.) VARIETIES

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ABSTRACT

The present study was aimed to find out the superiority amongst different use patterns in maize crop for higher yield, forage nutritional quality and profit. Three maize varieties each of baby corn, green cob, seed type and four forage type were grown together under field condition in *kharif* season 2011 and 2012. The mean green forage yield obtained from maize forage type was approximately 1.70 times higher than baby corn and seed type cultivars and 2 times than those of green cob type cultivars. The mean dry matter yield of forage type maize was 1.75, 1.60 and 1.35 times higher than baby corn, green cob and seed type, respectively. Forage type maize cultivar 'African Tall' gave significantly highest green forage yield, dry matter yield and crude protein yield. The highest mean per cent crude protein (8.5%), crude protein yield (7.38 q ha^{-1}) and *in vitro* dry matter digestibility (58.7%) with the lowest mean crude fibre content (22.0%) and acid detergent fibre (43.0%) was observed in forage type maize. The lowest mean neutral detergent fibre (62.7%) and highest mean gross monetary returns, net monetary returns, B: C (3.5) and fodder equivalent yield was found in baby corn type maize cultivars. In conclusion, growing fodder type cultivars were suitable for producing more fodder yield with better nutritional quality; however, the baby corn type cultivars for earning the highest net profit along with fodder under limited land resources.

Key words: Baby corn, economics, forage quality, maize-use patterns, yield

INTRODUCTION

To support the ever growing population in India, animal husbandry is the major supplementary occupation to farming. The livestock population of India was 512.05 millions in 2012 in which the number of milch animals (in-milk and dry) in cows and buffaloes has increased by 6.75% over the 18th livestock census of 2007 (Anonymous, 2014b). There is a gap of 40 and 36% in the demand and availability of dry and green fodder, respectively (Anonymous, 2014c). The adequate and regular supply of fodder is essential for development of dairy and livestock. The area under fodder crops has remained static (5%) during last two decades (Grover and Kumar, 2012). The area under maize cultivation was 9.4 million hectare with production of 23 million metric tonnes in 2013-2014. The area and production has increased at a growth rate of 2.5 and 5.5% from 2004-2005 to 2013-

2014 (Anonymous, 2014d). The growth in the area of maize crop is mainly due to the crop grown for different purposes. There are various ways to overcome fodder shortage. One of them is growing maize as dual purpose forage crop. The maize, 3rd important cereal crop after wheat and rice (Hongwei, 2006), has a wider potential to cope up this gap due to its higher yield potential. Maize is an extremely high yielding forage crop that produces high quality livestock feed at a very competitive price. Besides, the maize is grown widely for its superior fodder quality and is grown for human consumption as baby corn/ green cob. The baby corns and green cobs have higher demand in urban areas as well as it provides fodder for animals. The farmers have to purchase expensive fodder from the market and one of the ways to overcome fodder shortage is to grow maize as forage crop.

Growing of seed type varieties are promoted by the glucose producing industries in the country. Shanti *et al.* (2012) reported that higher fodder yield and better quality in forage type maize cultivars, whereas the order of return from different use patterns was as: baby corn > fodder crop > seed crop > green cob. However, Katoch and Kumar (2014) have shown higher fodder yield and better quality in forage type maize cultivars, whereas the order of returns from different use patterns was: baby corn> green cob>fodder crop>seed crop. Thus, the present study was aimed to compare the fodder quality of baby corn type, green cob type, seed type and forage type cultivars along with their yield and economic attributes under Maharashtra conditions.

MATERIALS AND METHODS

A field experiment was conducted on Research Farm of AICRP on Forage Crops and Utilization, Mahatma Phule Krishi Vidyapeeth, Rahuri (India) during 2010-11 and 2011-12. Three varieties each of baby corn type (Madhuri, Maharaja and Parmeshwar), green cob type (Local Sangli, Local Nashik and Komal), seed type (Bio-9881, Kargil and Karveer) and four forage type varieties (Manjari composite, Ganga Safed-2, Panchganga and African Tall) were grown in *kharif* (summer) season. The baby corn, green cob and seed type maize varieties were sown at plant spacing of 45 cm x 20 cm, while forage type maize varieties at 45 cm x 7.5 cm plant spacing with recommended dose of fertilizers (120:60:40 kg ha^{-1}). The experiment was laid in a factorial randomized block design and each replication replicated thrice. The baby corn type varieties were harvested for fodder after picking of the baby corns. The green cob type varieties were harvested for forage immediately after picking of green cobs, which is normally carried out after 60 days onwards, however maturity differed within the varieties. The fodder cultivars were harvested at early dough stage of cob and green fodder yield (GFY) was recorded, while seed type varieties were harvested at complete physiological maturity of seeds and seed yield taken after optimum sun drying. The baby corn was harvested 3-4 times depending on cultivar, whereas green cob was harvested at once and fresh yields were recorded. The representative forage samples were oven dried at 60^{o}C until constant weight to calculate dry matter yield (DMY). The dried samples were ground and passed through 1 mm sieve for biochemical analysis. The samples were analyzed for crude protein, crude fibre, total minerals, (AOAC, 2005), neutral detergent fibre (NDF), acid detergent fibre (ADF) using Pelican make Fibra plus equipment of Van Soest *et al.* (1991).

The *in vitro* dry matter digestibility (IVDMD) carried out by digesting the dried samples at 37^{o}C for 72 hr in 40 ml MC Dougall's buffer, pH 6.7 and 10 ml strained rumen liquor as a inoculum of micro-organisms collected from goat rumen (Tilley and Terry, 1963). The economics (net monitory returns and benefit: cost ratio) of different maize types was worked out using format of State Cost of Cultivation Scheme, Maharashtra state (Anonymous, 2010a). Maize green forage equivalent yield (q ha^{-1}) was calculated as gross returns/price of fodder. The data was statistical analysis using analysis of variance (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

Yield parameters

The forage type maize cultivars proved superior in yield parameters *viz.*, green forage yield, dry matter yield and crude protein yield over to all other types of cultivars under study (Table-1). The mean GFY obtained from forage type cultivars was the highest of 451.33 q ha^{-1}, followed by baby corn (265.85 q ha^{-1}), seed (247.44 q ha^{-1}) and green cob type (217.03 q ha^{-1}) cultivars.

The mean GFY of forage type is approximately 1.70 times more than baby corn (265.85 q ha^{-1}) and seed type (247.44 q ha^{-1}), while twice of the green cob type (217.03 q ha^{-1}) maize cultivars. Similar forage yield of baby corn type maize cultivars (107.55 q ha^{-1} to 266.93 q ha^{-1}) as reported by Kumar *et.al* (2015). All four forage type cultivars recorded higher GFY than rest of the maize cultivars and among all cultivars, African tall scored significantly highest GFY of 586.40 q ha^{-1}. The dry matter yield of forage type maize cultivars was 1.75 and 1.35 times more than baby corn and green cob types, respectively. The mean DMY of the forage type maize cultivars was the highest (88.74 q ha^{-1}), followed by seed type (64.83 q ha^{-1}), green cob (53.97 q ha^{-1}) and baby corn type (49.96 q ha^{-1}) maize cultivars. Forage type maize cultivar African Tall recorded significantly highest DMY (142.28 q ha^{-1}) than other cultivars. The lowest forage yield was recorded in baby corn, green cob and seed type maize cultivars because the yields of baby corn/green cob/ seed were not included in total dry matter/ green forage yield. Also the plant density in forage type maize cultivars was higher than other types. Similar results were reported by Carpici *et.al* (2010). The crude protein yield was calculated by multiplying crude protein per cent to dry matter yield. The crude

Table 1: Green fodder yield (GFY), dry matter yield (DMY), crude protein yield (CPY), baby corn, green cob and seed yield of maize cultivars grown under different use pattern

Varieties	Yield parameters			
	GFY (q ha^{-1})	DMY (q ha^{-1})	CPY (q ha^{-1})	Corn/ cob/seed yield (q ha^{-1})
Baby corn type				
Madhuri	209.60	40.66	2.91	63.39*
Maharaja	280.87	57.65	4.19	60.88*
Parmeshwar	307.08	51.57	3.69	63.12*
Mean	265.85	49.96	3.60	62.46*
Green cob type				
Local Sangli	163.63	42.98	3.16	78.97#
Local Nashik	230.32	55.70	3.21	86.42#
Komal	257.15	63.24	4.20	96.38#
Mean	217.03	53.97	3.52	87.26#
Seed type				
Bio-9881	187.60	56.22	3.60	55.52$
Kargil	297.08	75.48	4.76	46.95$
Karveer	257.64	62.81	4.14	50.51$
Mean	247.44	64.83	4.16	51.00$
Forage type				
Manjari Composite	459.07	80.49	7.15	-
Ganga Safed-2	386.25	63.98	5.54	-
Panchaganga	373.62	68.23	5.95	-
African Tall (C)	586.40	142.28	10.88	-
Mean	451.33	88.74	7.38	-
SE ±	26.88	9.21	0.62	-
$CD_{0.05}$	76.40	28.26	1.91	-

*Baby corn yield, #Green cob yield, $Seed yield

crude protein yield obtained from forage type cultivars was twice of the baby corn and green cob types and 1.75 times than that of seed type cultivars. The CPY was the highest (7.38 q ha^{-1}) in forage type and lowest in green cob type (3.52 q ha^{-1}) maize cultivars. The CPY of the forage type maize cultivar African Tall was significantly highest than all cultivars under study. Similar results of higher GFY and DMY in fodder type cultivars than other used patterns in maize were reported by Katoch and Kumar (2014). Chaudhary *et al*. (2012) reported higher green fodder yield and dry matter per cent in forage type maize cultivars than baby corn type maize cultivars.

Among the baby corn type maize cultivars, the highest baby corn yield was obtained in cv. Madhuri (63.39 q ha^{-1}), whereas among the green cob type maize cultivars, cv. Komal gave the highest green cob yield (96.38 q ha^{-1}). The highest seed yield of 55.52 q ha^{-1} was recorded in cv. Bio-9881. It was also observed that mean cob yield of green cob type varieties (87.26 q ha^{-1}) was greater than baby corn type varieties (62.46 q ha^{-1}) and the lowest in seed type varieties (51.00 q ha^{-1}). As green cob type varieties were harvested at a later stage than the baby corn type varieties, resulted into increased yield than baby corn type varieties. The lowest yield in seed type varieties attributed to decrease in moisture content at full maturity stage of seed. The results are in accordance with earlier reports of Katoch and Kumar (2014) who showed that cob yield from green cob varieties was higher than the baby corn and seed type varieties. Shanti *et al* (2012) concluded that cob yield from baby corn varieties was closely followed by green cob and lowest in seed type varieties.

Quality parameters

The forage quality *viz.*, crude protein, crude fibre, ash, neutral detergent fibre (NDF), acid detergent fibre (ADF) and IVDMD were analyzed from the dried samples of forage after harvesting the crop for different use patterns [Table 2]. The forage type cultivars had highest mean crude protein

Table 2: Crude protein content, crude fibre, total minerals, NDF, ADF contents and IVDMD of maize cultivars grown under different use patterns

Varieties Evaluated	Crude protein (%)	Crude fibre (%)	Total minerals (%)	Neutral detergent fibre (%)	Acid detergent fibre (%)	*In vitro* dry matter digest-ibility (%)
Baby corn type						
Madhuri	7.07	23.55	8.78	63.25	45.59	56.62
Maharaja	7.29	22.38	8.75	62.07	47.84	57.93
Parmeshwar	7.43	23.13	8.78	62.87	49.23	55.65
Mean	7.26	23.02	8.77	62.73	47.55	56.73
Green cob type						
Local Sangli	7.36	25.37	9.16	61.17	43.13	55.75
Local Nashik	5.80	23.16	8.54	63.95	44.59	53.48
Komal	6.67	24.16	9.03	64.45	45.02	55.65
Mean	6.61	24.23	8.91	63.19	44.25	54.96
Seed type						
Bio-9881	6.44	26.79	9.01	64.87	50.62	53.47
Kargil	6.34	24.75	9.23	64.70	49.19	53.14
Karveer	6.63	25.46	9.52	64.88	49.13	54.23
Mean	6.47	25.67	9.25	64.82	49.64	53.61
Forage type						
Manjari Composite	8.90	22.06	7.88	63.65	41.95	59.00
Ganga Safed-2	8.68	21.81	7.85	62.74	44.47	59.87
Panchaganga	8.78	21.44	8.03	63.57	42.43	58.07
African Tall (C)	7.66	22.77	8.57	62.95	43.20	57.81
Mean	8.50	22.02	8.08	63.23	43.01	58.69
SE ±	0.39	2.83	0.25	1.03	3.49	0.80
$CD_{0.05}$	1.21	8.67	ns	3.17	10.72	ns

content (8.50%) and *in vitro* dry matter digestibility (58.69%), but lowest mean crude fibre content (22.02%) and ADF (43.01%). The forage type cultivar 'Manjari composite' had the highest crude protein (8.9%) and lowest ADF (41.95%), whereas cv. 'Panchaganga' had lowest crude fibre (21.44%). 'Ganga Safed-2' had highest IVDMD (59.87%) than other maize cultivars evaluated. Forage type cultivars proved superior due to the highest crude protein content followed by baby corn, green cob and seed type maize cultivars. Ullah *et.al* (2015) reported maximum crude protein (12.70 %) and crude fibre (33.0 %) in forage type maize cultivars. Forage type cultivars also recorded highest *in vitro* dry matter digestibility with lowest crude fibre content. The lowest ADF was also recorded in forage type, followed by green cob, baby corn, and seed type maize cultivars. Katoch and Kumar (2014) reported highest crude protein content, *in vitro* dry matter digestibility and lowest crude fibre content in forage type cultivars than other use patterns. Shanti *et al.* (2012) reported highest IVDMD in 'African Tall'. As regards to neutral detergent fibres, baby corn type cultivars possessed lowest mean NDF of 62.73%, followed by green cob, baby corn and seed type cultivars. Amongst the all cultivars evaluated, 'Maharaja' had lowest NDF (62.07%) than other cultivars. Verma *et al.* (2013) reported significantly higher NDF content in baby corn planted on ridges than on flat beds.

Total mineral content remained unaffected due to different use patterns. However, the highest mean total mineral content of 9.25% was observed in seed type cultivars. Verma *et al.* (2013) reported that irrespective of cropping geometry and nitrogen doses the ash content remained unaffected. After reviewing the quality parameters it can be concluded that forage type cultivars prove it's superiority over other type of cultivars under study.

Economic parameters

The economics of maize production under different use patterns revealed that the gross monetary returns, net monetary returns, benefit cost ratio and fodder equivalent yield was recorded highest in baby corn type, followed by green cob, seed type and forage type maize cultivars (Table 3). Higher

Table 3: Economics of maize cultivars grown under different use patterns

Varieties	Economic parameters			
	Gross monetary returns (₹)	Net monetary returns (₹)	Benefit: cost ratio	Fodder equivalent yield (₹ ha^{-1})
Baby corn type				
Madhuri	80153	57172	3.36	1002
Maharaja	83353	53292	3.48	1042
Parmeshwar	87683	60386	3.67	1096
Mean	83730	56950	3.50	1046
Green cob type				
Local Sangli	63838	37622	2.98	798
Local Nashik	71413	44407	3.34	892
Komal	80286	51434	3.75	1003
Mean	71845	44488	3.36	898
Seed type				
Bio-9881	65207	18344	2.67	810
Kargil	61332	19403	2.53	766
Karveer	62956	15558	2.59	787
Mean	63165	17768	2.60	788
Forage type				
Manjari Composite	36726	18169	1.61	459
Ganga Safed-2	30900	8589	1.35	386
Panchaganga	29885	5144	1.31	373
African Tall (C)	46912	29067	2.05	586
Mean	36105	15242	1.58	451

net returns obtained by baby corn and green cob type maize cultivars is attributed to higher demand for baby corn in urban and peri urban areas which ultimately fetched higher prices alongwith higher green fodder yield (Rani *et.al*, 2011). The highest gross monetary returns (₹ 87,683/-), net monetary returns (₹ 60,386/-), benefit cost ratio (3.67) and fodder equivalent yield (₹1096 ha^{-1}) was obtained in cv. 'Parmeshwar', followed by cv. 'Madhuri' for net monetary returns. Different cultivars under study can be arranged in ascending order of their remuneration were baby corn type > green cob type >seed type > forage type. Shanti *et al*. (2012) reported higher economic attributes in baby corn type maize cultivars. Katoch and Kumar (2014) also reported higher gross monetary returns, net monetary returns, benefit cost ratio and fodder equivalent yields in baby corn type than other use patterns in maize. Thakur *et. al* (2008) reported that when baby corn was included in cropping system along with other crops, it resulted into higher returns than other cropping systems under study.

Conclusion: The forage type cultivars were found superior with respect to nutritional quality and fodder yield. However, it will be better to cultivate dual purpose maize for baby corn and fodder purpose for maximum economic returns and quality fodder.

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