



Nutritional quality of baby corn fodder as influenced by tillage practices and nitrogen management

MALLIKARJUN¹, HARDEV RAM², RAKESH KUMAR³, R K MEENA⁴, UTTAM KUMAR⁵ and
S K MANJUNATH⁶

ICAR-National Dairy Research Institute, Karnal, Haryana 132 001 India

Received: 15 December 2018; Accepted: 28 January 2019

ABSTRACT

An experiment was conducted at Karnal, Haryana to evaluate the effect of tillage practices and nitrogen management on yield and quality of baby corn fodder. The experiment was laid out in a split plot design with three replications having a combination of three contrasting tillage practices as main plots and six nitrogen management practices as sub plot treatments. Among tillage practices, significantly higher green fodder and dry matter (DM) yield was observed in raised bed (RB) over zero tillage (ZT) and conventional tillage (CT). Significantly higher cell content and lower neutral detergent fibre (NDF) content was observed in ZT over CT and RB, while significantly higher DM% and lower amount of neutral detergent insoluble crude protein (NDICP) and acid detergent insoluble crude protein (ADICP) were observed in RB and ZT over CT. Among nitrogen management options, significantly higher fodder and DM yield, DM%, total ash, CP, NDICP and ADICP was recorded in 125% N over 0, 75, 75 + *Azotobacter* and 100% N alone. However, 125% N was statistically at par with 100% N + *Azotobacter*. Significantly higher ether extract (EE) and lower NDF and cellulose content were observed in 100% N + *Azotobacter* and 125% N. The significant interaction effect was observed in green fodder and dry matter yield and RB with 125% N and 100% N + *Azotobacter* were superior over rest of the treatments. Among fodder quality parameters, significantly lower NDICP was observed in ZT with 125% N and 100% N + *Azotobacter* over rest of the treatments. Baby corn grown in RB/ZT with 100% N and seed inoculation with *Azotobacter* was a better strategy for higher yield and better fodder quality.

Key words: *Azotobacter*, Baby corn, Fodder quality, Nitrogen, Tillage

Maize is a potential crop in India and occupies an important place in human food (28%), livestock feed (11%), poultry feed (48%) and as a source of large number of industrial products (12%) and seed (1%) (Murdia *et al.* 2016). Among all the cereals, the growth of maize production is the highest because higher productivity per unit area, which is much higher than the major crops like rice and wheat (Farboodi *et al.* 2011). For diversification, value addition and growth of food processing industry, an interesting development is the growing maize for vegetable purpose as “baby corn”. Baby corn is a delicious and nutritive vegetable fetching a very high price in national and international markets. It is highly nutritive and its nutritional quality is at par or even superior to some of the seasonal vegetables.

Maize is also considered good fodder crop in the world because it is free from antinutritional factors, high

productivity, high energy and soluble carbohydrates than other forage crops. Soil degradation is a major problem; traditional deep inversion ploughing has been shown to promote the mineralization of soil organic matter (SOM) and thus its loss over time besides negative impacts on soil physical and biological activity (Buchi *et al.* 2015, Ram *et al.* 2017). To mitigate these negative effects, resource conservation technologies (RCTs) like zero tillage, bed planting and laser land levelling was tested and adopted to save substantial quantity of irrigation water, reducing the cost of cultivation in terms of land preparation, timely sowing, decreased seed rate, improved water and nutrient-use efficiency, and left indirect effect on mitigating the adverse effect of climate changes (Jat *et al.* 2014, Ram *et al.* 2018).

Nitrogen (N) is an essential and vital plant nutrient and a major component of protein, enzymes and nucleic acids and when N is deficient, growth is reduced hence availability in sufficient quantity throughout the growing season is essential for optimum maize growth. Nitrogen as a major constituent of cell plays a vital role in cell division and elongation by virtue of being an essential part of diverse type of metabolically active compound like amino acids,

Present address: ^{1,6}PG Scholar (kandhararjun@gmail.com, manjunath.skgowda@gmail.com), ^{2,4}Scientist (devagron@gmail.com, rajeshkumar2793@gmail.com), ³Principal Scientist (drdudi_rk@rediffmail.com), ⁵Chief Technical Officer (uttamkumar@gmail.com).

proteins, nucleic acids, flavins, purines and pyrimidine nucleotides, enzymes, co-enzymes and alkaloids. Therefore, it is vitally associated with the activity of every living cell. *Azotobacter* spp. are free-living N_2 fixer diazotroph that has several beneficial effects on the crop growth and yield through biosynthesis of growth regulating substances like auxins, cytokinin and gibberellic acid (Majumdar *et al.* 2007). In addition, it stimulates rhizosphere microbial activities, protects the crops from phyto-pathogens, improves nutrient uptake and ultimately boost up biological nitrogen fixation (Jnawali *et al.* 2015). Therefore, we planned an experiment to assess the feasibility of different tillage practices and nitrogen management for quality fodder production of baby corn.

MATERIALS AND METHODS

The experiment was conducted during 2017–18 at Agronomy Research Farm of the institute. Climatologically, Karnal belongs to subtropical climate and is subjected to extremes of weather conditions, i.e. extremely hot summer and cold winter. The experiment was laid out in a split plot design with three replications having a combination of three contrasting tillage practices as main plots, viz. zero tillage (ZT), conventional tillage (CT) and raised bed (RB) and six nitrogen management as sub plot treatments, viz. 0% N, 75% N, 75% N + *Azotobacter*, 100% N, 100% N + *Azotobacter* and 125% N. The allocations of treatment combination to different plots were done randomly by using random number table. After application of pre-sowing irrigation, experimental field was prepared as per the treatments. In conventional tillage, one deep ploughing followed by one harrowing to attain a friable tilth. In zero tillage, all preparatory tillage operations were avoided and sowing was done after 2–3 days of paraquat application by using zero till seed-drill. In raised bed; beds were made by using ridge maker and sowing was done manually. The recommended dose (150:60:40 of N: P_2O_5 : K_2O kg/ha) was applied as per treatments. The half dose of nitrogen, full amount of phosphorus and potassium was applied as basal. The remaining half dose of nitrogen was applied at 4-leaf stage and 40 DAS. After harvesting of baby corn, the entire plants were cut as green fodder from the net plot and the fresh weight was recorded and fodder yield was worked out on hectare basis. The representative fodder samples were collected, dried and grounded (Wiley mill) to pass through one mm screen for analysis of quality parameters. The ground samples were stored in polycarbonate bottles until analyzed. A known quantity of sample was taken in a pre-weighed aluminium tray/envelope paper. Tray was placed in hot air oven at 60–70°C for 48–72 h or until getting a constant weight (AOAC 2005). The dried samples were ground to pass 1 mm sieve for analysis of TA, CP, EE (AOAC 2005), cell wall constituents and cell wall associated protein fractions (NDICP and ADICP) (Van Soest *et al.* 1991). Cell content was calculated by subtracting NDF from 100 while T-CHO by subtracting TA, CP and EE from 100. Dry matter yield ($DM \times Fodder\ yield/100$), NDICP as CP% basis

(NDICP (DM%)/CP%) $\times 100$ and ADICP as CP% basis also calculated by (ADICP (DM%)/CP%) $\times 100$. The statistical analysis was done using analysis of variance in split plot design.

RESULTS AND DISCUSSION

The results revealed that among tillage practices, green fodder yield and dry fodder yield in RB increased to the tune of 4 and 11% and 5 and 14% over (Figs 1 and 2) ZT and CT respectively. This might be due to better growth and yield attributes, viz. plant height, leaf length, leaf width, number of leaves, leaf to stem ratio, leaf area index, and dry matter accumulation recorded in RB. These findings were in agreement with the findings of Sarang *et al.* (2017), Ram *et al.* (2018) and Yadav *et al.* (2016). However, in contrast findings were also reported by Das *et al.* (2014) and Kumar *et al.* (2016). Among nitrogen management options, fodder yield increased with increasing level of nitrogen and inclusion of *Azotobacter*.

The significantly higher green fodder and dry fodder yield was recorded in 100% N + *Azotobacter* to the tune of 44, 13, 9 and 6% and 64, 24, 14 and 9% higher over 0% N 75% N, 75% N + *Azotobacter* and 100% N, respectively. However, 100% N was statistically at par with 125% N.

This may be due to higher chemical N application with *Azotobacter* which might have improved the growth and yield parameter which resulted in higher fodder yield. The interaction effect between the tillage practices and nitrogen management was significant and higher green fodder yield and dry matter yield (Fig. 2) was recorded in RB with 125% N over remaining treatments but RB with 125% N was statistically at par with 100% N + *Azotobacter*.

Dry matter content of baby fodder was not influenced by tillage practices (Table 1). Among nitrogen management options, dry matter content of baby corn was increased with increasing level of nitrogen and significantly highest dry matter percentage was recorded in 125% N (20.45%) over 100% N (19.78%), 75% N + *Azotobacter* (19.49%), 75% N (18.59%) and 0% N (17.97%), but 125% N was statistically at par with 100% N + *Azotobacter* (20.32%). This might be due to higher level of nitrogen and *Azotobacter* application which resulted in more dry matter accumulation due to more biosynthesis (Meshram *et al.* 1982).

TA, CP, EE and T-CHO were not influenced by tillage practices (Table 1). Significantly higher total ash content of baby corn fodder was observed in 125% N, over rest of treatments. However, 125% N was statistically at par with 100% N + *Azotobacter*. This might be due to more uptake of nitrogen which resulted in more uptake of other minerals as nitrogen has synergetic effect with most of mineral nutrients which resulted in more mineral matter content at higher level of nitrogen application with *Azotobacter*. Similarly, among nitrogen management options, significantly higher crude protein content was recorded in 125% N over rest of treatments except, 125% N was statistically at par with 100% *Azotobacter*. Increasing

Table 1. Effect of tillage practices and N management on DM, CP, EE, total carbohydrates, cell content, and cell wall components (%) of baby corn fodder

Treatment	DM	Total ash	CP	EE	T-CHO	Cell content	NDF	ADF	Hemi cellulose	Cellulose	ADL
<i>Tillage practices</i>											
ZT	19.48 ^a	8.57	9.21	1.61	80.62	38.41 ^a	61.59 ^a	34.60	26.99	27.90	4.78
CT	19.17 ^b	8.50	9.11	1.47	80.92	36.44 ^c	63.56 ^b	35.49	28.07	28.19	4.90
RB	19.66 ^a	8.65	9.19	1.65	80.52	37.00 ^b	63.00 ^b	35.30	27.70	28.00	4.72
SEm±	0.07	0.09	0.09	0.10	0.22	0.25	0.25	0.30	0.42	0.06	0.11
CD (P=0.05)	0.28	NS	NS	NS	NS	0.98	0.98	NS	NS	NS	NS
<i>Nitrogen management</i>											
N ₀	17.97 ^d	7.93 ^{bc}	7.52 ^c	1.26 ^{bc}	83.30 ^c	34.63 ^d	65.37 ^c	36.98 ^c	28.38	29.86 ^f	5.09
N ₇₅	18.59 ^c	8.02 ^{bc}	8.31 ^d	1.44 ^{ab}	82.23 ^d	35.93 ^{bc}	64.07 ^{cd}	35.85 ^d	28.22	29.23 ^e	5.03
N ₇₅ +Bio	19.49 ^b	8.36 ^b	9.59 ^b	1.54 ^{ab}	80.51 ^c	36.93 ^b	63.07 ^{bc}	35.57 ^c	27.50	28.36 ^d	4.72
N ₁₀₀	19.78 ^b	8.65 ^{ab}	9.01 ^c	1.59 ^{ab}	80.75 ^c	37.91 ^{ab}	62.09 ^{ab}	34.49 ^b	27.60	27.69 ^c	4.71
N ₁₀₀ +Bio	20.32 ^a	9.09 ^a	10.22 ^a	1.69 ^a	79.00 ^b	38.83 ^a	61.17 ^a	33.96 ^b	27.21	27.12 ^b	4.65
N ₁₂₅	20.45 ^a	9.36 ^a	10.38 ^a	1.93 ^a	78.32 ^a	39.47 ^a	60.53 ^a	33.92 ^a	26.60	25.93 ^a	4.61
SEm±	0.13	0.19	0.10	0.09	0.22	0.40	0.40	0.36	0.58	0.12	0.15
CD (P=0.05)	0.36	0.54	0.29	0.25	0.64	1.15	1.15	1.05	NS	0.35	NS

NS, Non-significant.

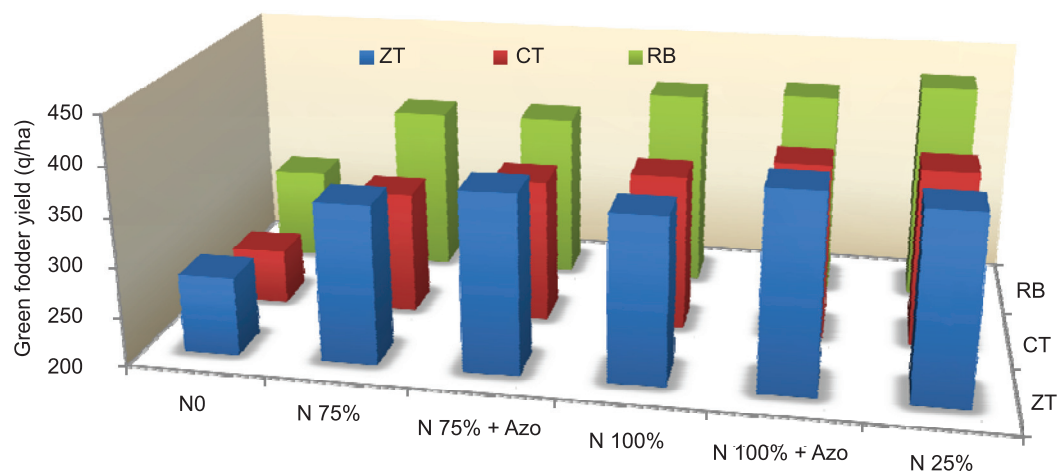


Fig. 1. Interaction effect of tillage practice and nitrogen management on green fodder yield of baby corn.

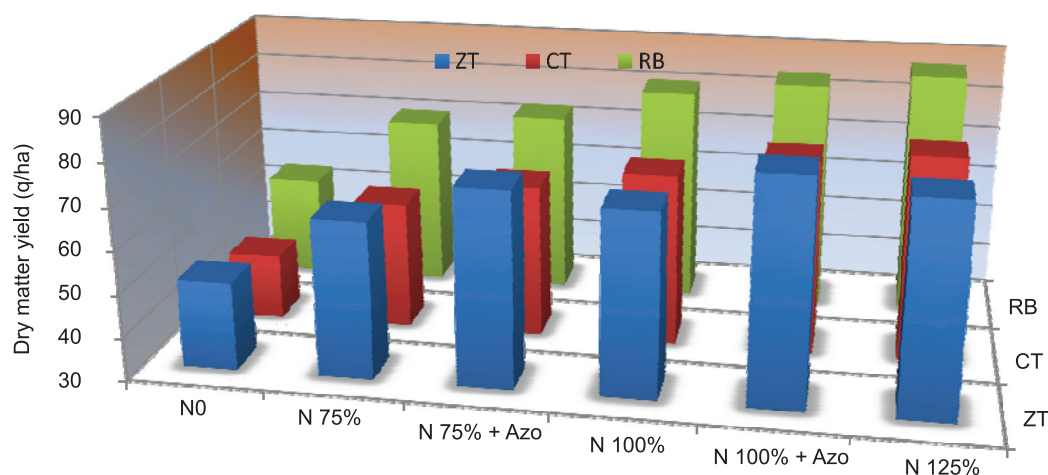


Fig. 2. Interaction effect of tillage practice and nitrogen management on dry matter yield of baby corn.

nitrogen levels and positive effect of *Azotobacter* application in term of N-fixation increased the protein synthesis and nitrogen concentration in plant cell that later increased crude protein content. Similarly, significantly higher EE content was recorded in 125% N (1.93%) over all the treatments. Because of additive effect between protein and fat synthesis, higher EE content at higher level of nitrogen was observed. Similar results were also reported by Dar *et al.* (2012). Cell content was significantly influenced by both tillage practices and nitrogen management, however, among tillage practices significantly higher cell content was recorded in ZT (38.41) over RB (37) and CT (36.44) (Table 1). Among nitrogen management options, significantly higher cell content was recorded in 125% N (39.47) over rest of treatments except, 125% N was significantly at par with 100% N + *Azotobacter*. This might be due to more protein and ether extract synthesis with higher level of N application (Tamta *et al.* 2018).

Significantly lower NDF content was observed in ZT (61.59%) over CT and RB. Low NDF content is good indicator of quality fodder and lowest value was recorded in ZT which indicated better growth and development under ZT over CT and RB resulting in lower fibre fraction. Among nitrogen management options, NDF, ADF and cellulose content decreased with increasing level of nitrogen but hemicellulose and ADL were not affected (Table 1). Significantly lower NDF content was recorded in 125% N (60.53%) over rest of treatments but 125% N was at par with 100% N + *Azotobacter*. Similarly, lower ADF content was recorded with 125% N (33.92%) over rest of treatments, but 125% N is statistically at par with 100% N + *Azotobacter* and 100% N. Significantly lower cellulose content was recorded in 125% N (25.93%), over rest of treatments. The higher dose of N enhanced more cell content which resulted in thinner cell wall components (Mallikarjun *et al.* 2018).

Among tillage practices, lowest NDICP was recorded in ZT (2.92 and 32.82), over RB and CT on DM and CP %, respectively (Table 4). Among nitrogen management options, significantly lower NDICP content was recorded in 125% N (2.58 and 24.94) over rest of treatments on DM and CP %, respectively. However, 125% N was statistically at par with 100% N + *Azotobacter*. The interaction effect between the tillage practices and nitrogen management on NDICP content was found significant and lowest NDICP content was recorded in ZT with 125% N (2.44 and 22.77) over all the treatments.

ADICP content of baby corn fodder was significantly influenced by tillage practices and nitrogen management. Among tillage practices, significantly lowest ADICP (DM and CP%) was recorded in ZT (1.43 and 16.01) over RB and CT, respectively (Table 2). Among nitrogen management options, significantly lowest ADICP (DM%) content was recorded in 125% N (1.28%) over rest of treatments, but 125% N was statistically at par with 100% N + *Azotobacter*. The same trend was also observed in ADICP (CP %) and lowest value was observed in 125% N (12.26) and 100% N + *Azotobacter* (13.14) over rest of the

treatments. Similar findings were also reported by Tamta *et al.* (2018).

Overall, it can be concluded that to realize higher productivity of quality fodder, baby corn could be planted with raised-bed and zero tillage along with application of 100% nitrogen with biofertilizer inoculation which had improved the total biomass yield. Good quality fodder may be helpful to sustain the performance of livestock in terms of fodder availability, animal health and milk production.

Table 2. Effect of tillage practices and nitrogen management on neutral and acid detergent insoluble crude protein content of baby corn fodder

Treatment	NDICP		ADICP	
	DM %	CP %	DM %	CP %
<i>Tillage practices</i>				
ZT	2.92 ^a	32.82 ^a	1.43 ^a	16.01 ^a
CT	3.11 ^{ab}	35.00 ^b	1.61 ^c	18.14 ^c
RB	3.00 ^a	33.17 ^a	1.53 ^b	17.14 ^b
SEm±	0.03	0.39	0.01	0.22
CD (P=0.05)	0.12	1.53	0.05	0.85
<i>Nitrogen management</i>				
N ₀	3.38 ^{cd}	44.97 ^c	1.84 ^c	24.52 ^c
N ₇₅	3.35 ^c	40.33 ^d	1.73 ^c	20.89 ^d
N _{75+Bio}	3.19 ^c	33.31 ^c	1.54 ^{ab}	16.09 ^c
N ₁₀₀	2.91 ^b	32.37 ^b	1.41 ^a	15.67 ^b
N _{100+Bio}	2.66 ^a	26.07 ^a	1.34 ^a	13.09 ^a
N ₁₂₅	2.58 ^a	24.94 ^a	1.28 ^a	12.33 ^a
SEm±	0.06	0.77	0.05	0.59
CD (P=0.05)	0.16	2.23	0.14	1.71
<i>Interaction effect</i>				
SEm±	0.10	1.34	0.09	1.03
CD (P=0.05)	0.28	3.86	NS	NS

REFERENCES

- AOAC. 2005. *Association of Official Analytical Chemists*. 18th edn. Official Methods of Analysis, Arlington, Virginia, USA.
- Majumdar B, Venkatesh M S and Saha R. 2007. Effect of nitrogen, farm yard manure and non-symbiotic nitrogen-fixing bacteria on yield, nutrient uptake and soil fertility in Upland Rice (*Oryza sativa* L.). *Indian Journal of Agricultural Sciences* 77(6): 335–39.
- Bhat J S and Patil B S. 2014. The story of baby corn. *Indian Farming* 63(12): 20–23.
- Buchi L, Amosse C, Wendling M, Sinaj S and Charles R. 2015. Introduction of no till in a long term experiment on soil tillage in Switzerland. *Aspects of Applied Biology* 128: 49–56.
- Dar E A, Ahmad S and Harika A S. 2014. Growth and yield of baby corn (*Zea mays* L.) as affected by different crop geometry and level of nitrogen application. *International Journal of Scientific Research* 3(8): 21–23.
- Das A, Ghosh P K, Verma M R, Munda G C, Ngachan S V and Mandal D. 2014. Tillage and residue mulching effect on productivity of maize (*Zea mays*)–toria (*Brassica campestris*) cropping system in fragile ecosystem of northeast Indian Himalayas. *Experimental agriculture* 51(1): 107–25.
- Das L K, Kundu S S, Kumar D and Datt C. 2015. Fractionation of carbohydrates and protein content of some forage feeds of

- ruminants for nutritive value. *Veterinary World* **8**: 197–202.
- Farboodi M, Alizadeh F A, Shahrokhi S and Ali R. 2011. *Azotobacter* inoculation, nitrogen fertilizer and manure levels. Effects on morphological characteristics of corn SC-647, in a greenhouse study. *International Conference on Biology, Environment and Chemistry* **24**: 23–26.
- Jat R K, Sapkota T B, Singh R G, Jat M L, Kumar M and Gupta R K. 2014. Seven years of conservation agriculture in a rice-wheat rotation of Eastern Gangetic Plains of South Asia: Yield trends and economic profitability. *Field Crop Research* **164**: 199–210.
- Jnawali A D, Ojha R B and Marahatta M. 2015. Role of bio fertilizer in soil fertility and sustainability: A Review. *Advances in Plants and Agriculture Research* **2**(6): 00069.
- Kumar S, Parihar S S, Singh M, Jat S L, Sehgal V, Mirja P R and Devi S. 2016. Effect of conservation agriculture practices and irrigation scheduling on productivity and water-use efficiency of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy* **61**(4): 443–48.
- Meshram S U and Shende S T. 1982. Response maize to *Azotobacter chroococcum*. *Plant and Soil* **69**: 265–73.
- Murdia L K, Wadhwani R, Wadhawan N, Bajpai P and Shekhawat S. 2016. Maize utilization in India: An overview. *American Journal of Food and Nutrition* **4**(6): 169–76.
- Ram H, Singh R K, Pal G, Kumar R, Yadav M R and Yadav T. 2017. Response of wheat (*Triticum aestivum*) genotypes to different tillage practices for improving productivity and seed quality in eastern Indo-Gangetic Plains of India. *Indian Journal of Agricultural Sciences* **87**(10): 1324–28.
- Ram H, Singh R K, Pal G, Agarwal D K and Kumar R. 2018. Effect of tillage practices and genotypes on growth, seed yield and nutrient uptake in wheat (*Triticum aestivum*). *Indian Journal of Agricultural Sciences* **88**(11): 1765–69.
- Sarangi S K, Maji B, Mandal U K, Mandal S and Sharma P C. 2017. Effect of establishment methods in rainy season (*kharif*) and tillage practices in winter season (*rabi*) on yield and economics of rice (*Oryza sativa*)–maize (*Zea mays*) cropping system under coastal saline ecosystem. *Indian Journal of Agronomy* **62**(4): 407–16.
- Tamta A, Kumar R, Ram H, Meena R K, Meena V K, Yadav M R and Subrahmanya D J. 2018. Productivity and profitability of legume-cereal forages under different planting ratio and nitrogen fertilization. *Legume Research* **42**(1): 102–07.
- Van Soest P J, Robertson J B and Lewis B A. 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Sciences* **74**: 3583–97.
- Yadav M R, Parihar C M, Jat S L, Singh A K, Kumar D, Pooniya V and Jat M L. 2016. Effect of long-term tillage and diversified crop rotations on nutrient uptake, profitability and energetics of maize (*Zea mays*) in north-western India. *Indian Journal of Agricultural Sciences* **86**(6): 743–49.
- Yadav M R, Parihar C M, Jat S L, Singh A K, Kumar R, Yadav R K and Jat M L. 2017. Impact of legume intensified crop rotations and tillage practices on maize productivity vis-à-vis C and N dynamics of a sandy loam soil in north-western Indo-Gangetic Plains of India. *Legume Research: An International Journal* **40**(6): 1028–37.