Indian Journal of Agricultural Sciences **92** (2): 263–6, February 2022/Article
https://doi.org/ 10.56093/ijas.v92i2.122249

Effect of tillage and nitrogen management on yields, profitability and nitrogen balance of baby corn (*Zea mays*)

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Received: 30 March 2021; Accepted: 31 August 2021

ABSTRACT

A field experiment was carried out during *kharif* 2016 and 2017 at ICAR-NDRI, Karnal to evaluate the effect of tillage and nitrogen management on productivity, quality and profitability of baby corn (*Zea mays* L.). The experiment consisted of 18 treatments comprising three tillage practices, viz. zero tillage (ZT), conventional tillage (CT) and raised beds (RB) as main plots while six nitrogen (N) management practices, viz. control, N75%, N75+Azotobactor, N100%, N100+Azotobactor and N125% were assigned in sub-plots in split plot design with three replications. Among tillage practices, RB showed significantly higher yield attributes, yield, green fodder (376.7 q/ha) and baby cobs yield (10.3 q/ha) over CT (346.7 and 8.38 q/ha) and ZT (363.6 and 9.36 q/ha). Among the N management options, increasing N levels increased growth and yield attributes and yield up to 100% N with application of Azotobactor. The maximum pooled cost of production was recorded under CT followed by RB and lowest in ZT. However, mean net return was observed highest under RB (₹111.9 lakh/ha) followed by ZT (₹103.6 lakh/ha) and lowest in CT (₹89.3 lakh/ha). The saving in total cost of cultivation due to ZT was ₹900 to 2,500/ha, as compared to RB and CT, respectively. Hence, to realize higher productivity, profitability and sustain soil health, baby corn planted under raised bed with application of 100% N with azotobactor was quite cost efficient, this can further strengthen and sustain the performance of livestock in terms of quality green fodder availability.

Keywords: Azotobactor, Baby corn, Nitrogen, Tillage

Maize (*Zea mays* L.) is most important crop in the world because of its high yield potential and adaptation to diverse climatic conditions than other crops. It occupies an important place as food (13%), animal feed (13%), poultry feed (47%) processed food products (7%), starch (14%) and in other uses (6%) (FICCI 2018). Baby corn consists of the corn ear harvested 2–3 days after silk emergence and before fertilization. The marketable cobs have 7–10 cm length and 2–3 cm diameters of dehusked cobs harvested at 50–55 DAS. It is considered a good fodder crop because it is free from antinutritional factors, has high productivity, energy and soluble carbohydrates compared to other forage crops. Currently, India is facing dual problem of feeding the ever-increasing human (1.39 billion) and livestock (512 million) population and shrinking land resources. As per latest estimation, country is facing a net deficit of 11.2% green fodder, 23.4% dry fodder and 28.9% concentrates feed making livestock rearing more challenging (NAAS 2016).

Crop establishment, water and nutrients are the most crucial monetary inputs for optimum crop production. Apart from these, soil degradation is also a major issue and traditional deep inversion ploughing has been shown to promote the mineralization of soil organic matter and thus its steady decline over time (Buchi *et al,* 2015). To mitigate these adverse effects, resource conservation technologies (RCTs) like direct drilling, zero tillage, bed planting and laser land leveling etc. have saved substantial quantity of irrigation water, reducing the cost of cultivation in terms of land preparation, timely sowing, decreased seed rate, improving water and nutrient-use efficiency and also has indirect effect on mitigating the adverse effect of climate changes (Jat *et al.* 2014, Ram *et al.* 2018). Chemical fertilizers being quite expensive have high cost of production and also adversely impact soil health and microbial population. Being economically and environmental friendly, biofertilizers can be used in crop production for better yield and sustainable soil health (Arjun *et al.* 2015, Rana *et al.* 2018). Therefore, the present study has been conducted to assess the feasibility of different tillage and nitrogen management options including

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bio-fertilizer for detailed understanding of the effect on yield and quality of baby corn.

MATERIALS AND METHODS

The field experiments were carried out during *kharif* 2016 and 2017 at ICAR-National Dairy Research Institute, Karnal, Haryana, located at 29º68' N, 76º99' E and at an altitude of 257 m above mean sea level. The climate of the study area is semi-arid, with a mean annual rainfall of 650 mm with mean annual evaporation of 850 mm. The soil of experimental site was sandy clay loam in texture with *p*H 7.9, Walkley–Black C (0.55%), EC (0.32 dS/m), $KMnO_4$ oxidizable N (204.8 kg/ha), 0.5 M $NaHCO_3$extractable P (18.5 kg/ha) and 1 N NH_4OAC extractable K (285.5 kg/ha). The experiment consisted of 18 treatment combinations comprising of 3 tillage systems, viz. Zero tillage (ZT), Conventional tillage (CT) and Raised Beds (RB) as main plots while six nitrogen management practices, viz. N0, N75%, N75+Azotobactor, N100%, N100+Azotobactor and N125% were assigned in sub-plots under split plot design with three replications. Each experiment unit was 18 m^2 in area. The baby corn was sown under ZT after application of glyphosate @0.5 kg *a.i.* per ha before sowing at proper moisture, while in CT, crop was sown as farmers' practices with a tractor drawn seed drill using a seed rate of 25 kg/ha and a spacing of 50 cm × 20 cm. In RB, 1 row of maize on each bed (50 cm apart) was established using 25 kg/ha seed rate while under ZT plots, the crop was sown without any preparatory tillage with a seed rate of 25 kg/ha and spacing of 50 cm × 20 cm. Before sowing, seeds were treated with azotobactor culture as per the treatments. The recommended dose of N:P:K (150:50:40 kg/ha) was applied through urea, diammonium phosphate and muriate of potash as per the treatments, respectively. Full doses of P and K along with half dose of N were applied as basal and remaining N was applied in 2 splits at knee high stage (20 DAS) and before silk emergence (45 DAS). The weeds in experimental plots were controlled using pre-emergence herbicides using Atrazine (1.0 kg *a.i.* per ha). The data on crop inputs i.e. tillage, irrigation, herbicide application, labour use etc. for each treatment were recorded as per standard procedure. The field observations were recorded from ten plants in each plot, selected randomly. The tagged plants, fodder and baby corn yield was determined by net area basis after border rows removed. The cost of cultivation and net returns were calculated by taking into account the prevailing cost of inputs, baby corn (100–125 ₹/kg) and local market price of fodder (100 ₹/q). All the data was statistically analyzed using the analysis of the variance (ANOVA) technique. The critical differences at 0.05% level of probability were calculated to assess the significance between treatments if significant (Gomez and Gomez 1984).

RESULT AND DISCUSSION

Effect of tillage practices and nitrogen management on yields attributes: The tillage and N management option significantly influenced yield attributes, viz. days to initiation of baby cobs, no. of baby cobs per plant, weight of baby corn, and baby corn girth (Table 1). The results revealed that the number of days to cob initiation, number of cobs per plant and weight of baby corn were significantly higher under RB (52.7 days, 3.13 cm, 11.23 g), over ZT and CT, respectively. The better yield attributes of baby corn observed in RB might be due to adequate water, nutrient availability and

Table 1 Effect of tillage practices and nitrogen management on yields attributes, yield and economics

Treatment	Days to initiation of baby cobs	No of baby cobs per plant	Weight of baby corn (g)	Green fodder yield (q/ha)	Baby corn yield (q/ha)	Gross returns (₹ × 10^3/ha)	Net returns (₹×10^3/ha)
Tillage practice							
ZT	54.4	2.98	11.09	363.6	9.4	130.2	103.6
CT	56.0	2.69	10.22	346.7	8.4	118.4	89.3
RB	52.7	3.13	11.23	376.2	10.3	140.1	111.9
SEm±	0.5	0.02	0.10	2.25	0.07	1.29	1.29
LSD($P\leq0.05$)	1.8	0.08	0.39	8.84	0.28	5.09	5.09
Nitrogen management							
Control	56.7	1.96	8.46	276.8	3.5	64.3	39.0
N75%	56.0	2.24	9.86	352.4	6.7	102.8	74.7
N75%+Azo	54.4	3.25	11.47	366.6	9.6	132.4	104.2
N100%	53.7	3.24	11.52	377.2	10.5	142.9	114.3
N100% + Azo	52.6	3.35	11.82	396.5	12.9	168.4	139.8
N125 %	52.7	3.57	11.95	398.4	12.7	166.5	137.5
SEm±	0.7	0.05	0.17	3.51	0.10	1.57	1.57
LSD($P\leq0.05$)	2.0	0.15	0.50	10.13	0.29	4.56	4.56

ZT, Zero tillage; CT, Conventional tillage; RB, Raised bed; Azo, Azotobactor.
Mean of two years

better aeration which enhanced growth and yield attributes under RB over ZT and CT (Yadav *et al.* 2016).

Among the nitrogen management practices, early cob initiation, no. of baby cobs per plant and baby corn weight were significantly observed in lower level of N application with biofertilizer application (75% N+Azotobactor) over control and 75% N application through chemical N. However 75% N+Azotobactor was on par with higher levels of N. Application of azotobactor contributing optimum N availability to the crop resulted in better yield attributes by stimulating rhizospheric microbes, biosynthesis of growth substances, modification of nutrient uptake leading to higher yield attributes (Arjun *et al.* 2015).

Effect of tillage practices and nitrogen management on yield and economics: The significantly higher green fodder and baby corn yields were recorded under raised bed baby corn as compared to other tillage practices (Table 1). The magnitude of increased green fodder and baby corn yield under RB were 8.5 and 22.3% over CT, and 3.5 and 9.1% over ZT, respectively. However, ZT also recorded significantly higher yield of green fodder and baby corn in tune of 4.8 and 12.0% over CT, respectively. Higher green fodder and cob yield in RB and ZT over CT might be due to better growth and yield attributes. The higher yield of maize in RB/ZT could be due to the compound effects of additional nutrients, reduced competition for resources, improved soil physical health and better water regimes (Rajanna et al. 2019, Rathore et al. 2020) with higher resource-use efficiency, aeration and efficient nutrient use over CT. In addition to all these factors, root growth was better under RB and ZT compared to CT due to lesser compaction (Yadav et al. 2016), higher value of total soil N, water holding capacity (WHC), SOC content was higher (1.2 times) in non-tilled beds compared to tilled beds. In CT, destruction of soil aggregates which reduces WHC, resulted in reduced water availability to plants and decreased yield. Similar findings were also reported by Sarangi et al. (2017) and Kumar et al. (2018).

In the nitrogen management practices, both green fodder and baby corn yield were significantly increased up to the application of 100% N with azotobactor applications. The green fodder and baby corn yield increased in 100% N + azotobactor, about 25.8, 9.8, 7.0 and 4.0 and 72.7, 47.8, 25.7 and 18.5% over control, 75% N, 75% N+azotobactor and 100% N, respectively. The application of 100% N+azotobactor improved growth and yield attributes, which consequently increased the yields. Besides these, seed inoculated with azotobactor helps in uptake of N, P and micronutrients and produces growth substances like Indol-3-Acetic acid (IAA) directly affecting the nutrient availability and growth which positively influence the maize photosynthesis and dry matter accumulation (Arjun *et al.* 2015, Mallikarjun *et al.* 2019).

Cost of cultivation, net returns and B:C ratio are important indicators for selection of remunerative tillage practices and input management, which have shown a wide variation among all the treatments (Table 1). Because of higher green fodder and baby corn yield under RB, it was most remunerative and recorded highest gross (₹140.1, 10^3/ha) and net returns (₹111.9, 10^3/ha). The tillage and crop establishment methods contribute a major share of total cost of cultivation (Rajanna *et al.* 2018). In case of nitrogen management highest gross, net returns and B:C ratio was recorded in 100% N+Azotobactor followed by 125% N and least in control. This is due to the high yield recorded in above treatment.

Effect of tillage practices and nitrogen management on nitrogen budgeting: The nitrogen budgeting was worked out by comparing the soil available, applied and total removal of N under different treatment combination and the result

Table 2 Effect of tillage practices and nitrogen management on nitrogen budgeting

Treatment	Initial soil available nitrogen (A)	Nitrogen applied as chemical fertilizer (B)	Nitrogen uptake by crop (C)	Soil available nitrogen after harvest of crop (D)	Expected nitrogen balance [X,(A+B)-C]	Actual gain or losses [Y,(D-A)]	Apparent gain or losses [Z,(D-X)]
Tillage practice							
ZT	185.5	119.0	112.2	190.9	192.3	5.4	-1.4
CT	185.5	119.0	103.1	172.8	201.4	-12.7	-28.5
RB	185.5	119.0	119.4	177.6	185.1	-7.9	-7.5
Nitrogen management							
Control	185.5	0.0	64.9	158.3	120.6	-27.2	37.7
N75%	185.5	113.0	92.7	173.6	205.8	-11.9	-32.2
N75%+Azo	185.5	113.0	114.7	183.7	183.8	-1.8	-0.1
N100%	185.5	150.0	113.9	180.7	221.6	-4.8	-40.9
N100% + Azo	185.5	150.0	138.7	196.2	196.8	10.7	-0.5
N125%	185.5	188.0	144.5	190.2	229.0	4.7	-38.8

ZT, Zero tillage; CT, Conventional tillage; RB, Raised bed; Azo, Azotobactor.

Mean of two years.

showed remarkable variation among the treatments. The magnitude of residual available N in the soil improved with application of azotobacter over chemical fertilizers alone (Table 2). The highest N uptake by crop was recorded in order of RB > ZT > CT, this is due to the same trends that was observed in yield. Among the tillage practices, higher actual and apparent N gain/losses (5.4 and -1.4 kg/ha) over initial soil available N were recorded in ZT. However, highest actual and apparent losses were recorded in CT (-12.7 and -28.5 kg/ha) and RB (-7.9 and -7.5 kg/ha), respectively. Under different nitrogen management options, higher actual gain was recorded in 100% N with azotobacter application (10.7 kg/ha) over initial N content but apparent gain was highest in control treatment (37.7 kg/ha). The highest apparent gain was recorded in control due to the rhizosphere microbes that utilized their maximum potential for regaining nutrient status (N) with support from external and internal factors and low yields resulted in less uptake of N in control treatment (Sharma and Banik 2012).

Overall, it can be concluded that to realize higher productivity of baby corn, it can be planted on raised-beds along with application of 100% nitrogen and seed inoculation with azotobacter which might improve the yield, quality and sustain soil health.

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