*Indian Journal of Agronomy* **61** (4): 512–514 (December 2016)

**Research Communication**

# Effect of different nitrification inhibitors doses and varying nitrogen levels on productivity and economics of hybrid maize (*Zea mays*)

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Received : October 2016; Revised accepted : December, 2016

## ABSTRACT

A field experiment was conducted during the rainy season of 2013 at New Delhi, to study the yield and economics of 'PMH 3' maize hybrid (*Zea mays* L.) under different doses of nitrification inhibitors and varying levels of nitrogen. The experiment was laid out in a randomized block design with 14 combinations of 3 nitrification inhibitors (dicyandiamide, neem oil and meliacin) each with 2 different concentrations and 2 levels of nitrogen (135 and 180 kg/ha). Highest number of cobs/plant, grain rows/cob and grains/row were recorded with the application of $MCU_{350}$ @$N_{180.}$ The grain yield, stover yield and harvest index of maize as influenced by different doses of nitrification-inhibitors and varying levels of nitrogen were found significant and the highest grain and stover yield (7.25 and 7.93 t/ha) were recorded with the application of $MCU_{350}$ @$N_{180}$. $DCD_{10\%}$ @ $N_{180}$ recorded the highest cost of cultivation (₹38,813/ha), whereas highest net returns (₹68,482/ha) and net returns/rupee invested (1.99) were recorded under $MCU_{350}$@$N_{180}$ followed by $MCU_{700}$ @$N_{180}$ (₹66,832/ha, 1.93), while the minimum (₹23,633/ha, 0.74) in the control.

***Key words*** : Economics, Hybrial maize, Nitrification inhibitors, Productivity

Maize is the third most important cereal crop after rice and wheat in India. In India, maize is cultivated in 8.71 million ha with a production of 22.3 million tonnes and the average yield is 2.55 t/ha (DMR, 2013). It is utilized as a human food and livestock feed, besides serving as a source to several hundred industrial products that include starch, oil, protein, alchoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc. (Kumar *et al*., 2012). Nitrogen is very important nutrient responsible for better growth and development of maize plant, as it plays an important role in plant metabolism. With the development of single-cross hybrids, greater amount of nitrogen up to 180 kg N/ha is required by maize crop for exploiting its potential. But the excessive use of nitrogenous fertilizers has raised various global concerns mainly due to the low efficiency of nitrogenous fertilizers, resulting in low yield, negative impact on atmosphere, groundwater pollution and hazardous effects on other components of ecosystem. On an average recovery of fertilizer nitrogen in India ranges from 20 to 50% (Prasad *et al.,* 1998). Urea is the major source of nitrogen, which suffers from low nitrogen-use efficiency due to its tendency to lose a substantial portion of the nitrogen values by ammonia volatilization and rapid nitrification leading to nitrate leaching followed by denitrification. This rapid nitrification is one of the key factors of inefficient nitrogen use, particularly in warmer climate such as India. Under these circumstances, increasing crop yield per unit area through the use of appropriate nitrogen-management practices has become an essential component of modern crop production (Fageria and Barbosa-Filho, 2001). Most of the nitrification-inhibitors such as nitrapyrin, A.M. (2-amino-4-chloro-6- methylpyridine), dicyandiamide and ammonium thiosulphate remain still unpopular with most Asian farmers due to their higher costs and limited availability. Hence a need is being increasingly felt to identify and use some new indigenous nitrification-inhibitors for increased growth, development and crop yields of maize.

A field experiment was conducted at Research farm of Division of Agronomy, Indian Agricultural Research Institute, New Delhi (28.4° N, and 77.18° E, 228 meters above the mean sea-level). The site has semi-arid and sub-tropi-

Based on a part of M.Sc. thesis of the first author submitted to Indian Agricultural Research Institute, New Delhi 110 012 (unpublished)

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cal climate characterized by hot dry summer and cold winter. The daily minimum and maximum temperature ranged from 26 to 44.5°C and 7.7 to 29.8°C, respectively, and the total rainfall of 494 mm was received during the crop period. The soil of the experimental field was sandy loam, low in organic carbon and available N; and medium in available P and K with *p*H 7.7. The experiment consisted of 14 treatments with 3 nitrification-inhibitors (dicyandiamide, neem oil and meliacin), each with 2 different concentrations having 2 levels of nitrogen (135 and 180 kg/ha), was laid out in randomized block design and replicated thrice. The crop was planted on ridges made at 75 cm and intra-row spacing of 20 cm. The per hectare recommended dose of $P_2O_5$ (60 kg) and $K_2O$ (50 kg) were applied to the crop in the form of single superphosphate (16% $P_2O_5$) and murate of potash (60% $K_2O$) respectively, as basal. One-third nitrogen as per treatments was applied basal and the remaining was applied in 2 equal splits – at knee height and pre-teaseling stages as per the treatments. The zinc sulphate @ 25 kg/ha application was also applied basal uniformly in all the plots. The total number of gain rows and grains/row from selected 5 cobs were counted and averaged out to get grain rows/cob and grains/row. Shelling percentage was worked out as ratio of grain weight to the cob weight of 5 randomly selected cobs and multiplied by 100. Test (1,000-seed) weight measured by taking representative sample from the grain yield obtained in each plot and weighed for 1,000-grain. Fresh weight of the cob was recorded for each net plot and grain yield was worked out on the basis of shelling percentage of that plot and adjusted to the 15% grain-moisture content. The maize stover of the net plot were removed just near the ground with the help of sickle and weighed after the sun drying. The harvest index was worked out from the grain yield divided by grain + stover yield per hectare and multiplied by 100.

The different yield attributes like cobs/plant, grain rows/cob and grains/row were affected significantly due to different levels of nitrogen, while different nitrification-inhibitors and their concentration failed to achieve any significant difference in yield attributes (Table 1). The highest cobs/plant was recorded with $MCU_{350}$ @ $N_{180}$, being at par with $NOCU_{700}$ @ $N_{180}$ and $MCU_{700}$ @ $N_{180}$, while the lowest value was recorded in absolute control. Number of grain rows/cob and grains/row was recorded highest in $MCU_{350}$ @ $N_{180}$, while different nitrification-inhibitors were failed to achieve any significant difference in grain rows/cob and grains/row. The highest grain yield (7.25 t/ha) and stover yield (7.93 t/ha) were obtained with $MCU_{350}$ @ $N_{180}$, followed by $MCU_{700}$ @ $N_{180.}$ These increase in grain and stover yields was 15.81 and 10.44%, respectively, over180 kg N/ha through urea without any nitrification-inhibitor. There was an improvement in grain yield with the application of $MCU_{350}$ @ $N_{180}$ over $MCU_{700}$ @ $N_{180}$ probably owing to fact that the increased coating thickness of meliacin from 350 to 700 ppm reduced $NO_3^-$ –nitrogen availability for plants and lower yield was obtained with the application of $MCU_{700}$ @ $N_{180.}$ The highest harvest index was observed under $MCU_{700}$ @ $N_{180}$ which was comparable with all other treatments except absolute

**Table 1.** Effect of different doses of nitrification-inhibitors and varying levels of nitrogen on yield attributes, grain yield and economics of hybrid maize 'PMH 3'

| Treatment | Cobs/ plant | Grain rows/cob | Grains/ row | 1,000-seed weight | Grain yield (t/ha) | Stover yield (t/ha) | Harvest index (%) | Cultivation cost (₹/ha) | Net returns (₹/ha) | Benefit: cost ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| Control | 1.0 | 11.1 | 36.3 | 216.7 | 3.80 | 5.88 | 39 | 32,063 | 23,633 | 0.74 |
| Urea @$N_{180}$ | 1.2 | 13.2 | 40.0 | 235.0 | 6.26 | 7.18 | 47 | 34,133 | 55,084 | 1.61 |
| $NOCU_{350}$ @ $N_{135}$ | 1.1 | 12.3 | 41.3 | 231.0 | 5.68 | 6.97 | 45 | 33,703 | 47,669 | 1.41 |
| $NOCU_{350}$ @ $N_{180}$ | 1.2 | 14.1 | 42.3 | 235.0 | 6.68 | 7.23 | 48 | 34,250 | 60,533 | 1.77 |
| $NOCU_{700}$ @ $N_{135}$ | 1.1 | 12.3 | 41.0 | 246.0 | 6.15 | 6.69 | 48 | 33,791 | 53,405 | 1.58 |
| $NOCU_{700}$ @ $N_{180}$ | 1.4 | 14.0 | 42.0 | 242.3 | 6.97 | 7.41 | 48 | 34,367 | 64,408 | 1.87 |
| $MCU_{350}$ @ $N_{135}$ | 1.1 | 12.3 | 37.7 | 229.0 | 6.24 | 7.29 | 46 | 33,791 | 55,287 | 1.64 |
| $MCU_{350}$ @ $N_{180}$ | 1.3 | 13.3 | 42.0 | 246.0 | 7.25 | 7.93 | 48 | 34,367 | 68,482 | 1.99 |
| $MCU_{700}$ @ $N_{135}$ | 1.1 | 12.3 | 39.7 | 246.3 | 6.10 | 6.21 | 49 | 33,966 | 52,161 | 1.54 |
| $MCU_{700}$ @ $N_{180}$ | 1.4 | 14.0 | 43.0 | 250.7 | 7.14 | 7.95 | 47 | 34,602 | 66,832 | 1.93 |
| $DCD_{5\%}$ @ $N_{135}$ | 1.1 | 12.3 | 42.3 | 241.7 | 6.17 | 7.02 | 47 | 35,373 | 52,464 | 1.48 |
| $DCD_{5\%}$ @ $N_{180}$ | 1.3 | 14.3 | 42.3 | 246.3 | 6.60 | 7.27 | 48 | 36,473 | 57,318 | 1.57 |
| $DCD_{10\%}$ @ $N_{135}$ | 1.1 | 12.7 | 42.0 | 236.7 | 5.46 | 6.63 | 45 | 37,131 | 41,038 | 1.11 |
| $DCD_{10\%}$ @ $N_{180}$ | 1.3 | 14.3 | 38.0 | 249.0 | 6.35 | 7.24 | 47 | 38,813 | 51,564 | 1.33 |
| SEm± | 0.09 | 0.71 | 1.20 | 14.30 | 0.20 | 0.21 | 1.2 | - | 2,656 | 0.073 |
| CD (P=0.05) | 0.27 | 2.06 | 3.49 | 41.50 | 0.60 | 0.61 | 3.4 | - | 7,723 | 0.211 |

control, $NOCU_{350}$ @ $N_{135}$ and $DCD_{10\%}$ @ $N_{180.}$ The $MCU_{700}$ @ $N_{135}$ reduced lower stover yield and that was the reason of highest harvest index. It is now evident that $MCU_{350}$ @ $N_{180}$ benefitted the crop most, perhaps by delaying the nitrification of urea and synchronizing N release with the crop demand.

Cost of cultivation, gross returns, net returns and benefit: cost ratio were significantly affected by different doses of nitrification-inhibitors and levels of nitrogen. The cost of cultivation of maize crop under different treatments varied from minimum with absolute control (₹32,063/ha) to maximum with the application of $DCD_{10\%}$ @ $N_{180}$ (₹38,813/ha). Application of nitrogen with DCD markedly increased the cost of cultivation. The maximum gross returns (₹102,850/ha), net returns (₹68,482/ha) and net returns/rupee invested (1.99) were recorded under $MCU_{350}$ @ $N_{180}$ followed by $MCU_{700}$ @ $N_{180}$, while minimum in the control. This was probably due to higher production of grain and stover yield and lower cost of cultivation. Although gross returns were higher with the application of $DCD_{5\%}$ @ $N_{180}$, net returns were lower due to higher cost of cultivation. Similar results were found by Diez *et al.* (2008) and Jat *et al*. (2014).

It was concluded that to get maximum productivity and profitability from hybrid maize 'PMH 3' the crop should be fertilized with $MCU_{350}$ @ $N_{180}$ which reduce losses of nutrients from the farmer fields.

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