The Andhra Agric. J 63 (4): 741-746, 2016

Nutrient Management in Zero Till Maize for North Coastal Zone of A P

S Sravanthi, A V Ramana, K V Ramana Murthy and J Jagannadam
Department of Agronomy, Agricultural College, Naira 532 185, Andhra Pradesh

ABSTRACT

A field experiment was conducted during *rabi*, 2014-15 on sandy loam soils of Agricultural College Farm, Naira, to study the effect of N levels and micronutrient management practices on maize under zero till conditions. The experiment was laid out in split-plot design with three nitrogen levels and seven micronutrient management practices, each replicated thrice. Significantly higher growth stature, yield structure and yield were obtained with the highest level of N supplied (240 kg ha^{-1}) compared to successive lower levels. Among the micronutrient management practices, foliar application of micronutrient mixture @ 0.2% twice at 20 & 40 DAS was found to significantly enhance growth, yield attributes and kernel yield. The highest kernel yield was obtained with the highest level of nitrogen applied @ 240 kg ha^{-1} and supplemented with micronutrient mixture, which was however found parity with same micronutrient management practice at immediate lower level of N @ 180 kg ha^{-1}. While, the kernel yield with 120 kg N ha^{-1} and supplemented with foliar application of $ZnSO_4$ @ 0.2% twice at 20 & 40 DAS produced the lowest kernel yield (4090 kg ha^{-1}). Maximum gross returns, net returns and B: C ratio were observed with the application of N @ 240 kg ha^{-1} and supplemented with micronutrient mixture, which was however found parity with same micronutrient management practice at immediate lower level of N @ 180 kg ha^{-1}.

Key words : Nitrogen levels, Micronutrients, Yield, Zero till maize.

Maize is one of the most important cereal crops occupying a prominent position in global Agriculture. In India, maize is grown in 8.6 M ha with an annual production of 22.5 M t. In Andhra Pradesh, it is grown on an area of 8.5 lakh ha with a production of 42.21 lakh tonnes.

Rice-relay pulse is an important crop sequence covering three lakh ha in Andhra Pradesh. For the past half decade, green gram and black gram have been suffering due to yellow vein mosaic and cuscuta problem and in the absence of immediate solution to these problems, rice-pulse sequence is being replaced by rice-zero till maize sequence as the latter is endowed with unparallel cultivars and technology improvement. Due to higher productivity, profitability and assured alternative *rabi* crop after rice, acreage of maize has shown an increasing trend and emerged as a potential alternative to rice fallow pulse. In zero tillage technology, fertilizer application is challenging and therefore to derive complete benefit of zero tillage with maize crop a high nutrient feeder, there is every need to improve input use efficiency by timely foliar sprays with micronutrients and proper placement of fertilizers. Low fertility is one of the reasons for low productivity hence, sustainable yield levels could be achieved only by application of appropriate combination of fertilizers. Hence, there is every need to evaluate the best nutrient management practice to realize higher productivity of zero till maize.

MATERIAL AND METHODS

A field experiment was conducted during *rabi* of 2014-15 at the Agricultural College Farm, Naira, Andhra Pradesh. The soil was sandy loam in texture with a pH of 7.3 and EC of 0.15 dSm^{-1}, low in organic carbon (0.3%) and available nitrogen (257.5 kg ha^{-1}), medium in available phosphorus (22 kg ha^{-1}) and potassium (312.5 kg ha^{-1}). Healthy and bold seeds of maize hybrid »DHM- 117 ¼ were dibbled into the soil @ one seed $hill^{-1}$ at a spacing of 60 cm x 25 cm at a seed rate of 20 kg ha^{-1} on 29 th November, 2014. The plot size was 4.8 m × 5 m. The experiment was laid out in split plot design comprising of 21 treatment combinations with three nitrogen levels; NPK @ 120-60-60 kg ha^{-1} (S_1), NPK @ 180-60-60 kg ha^{-1} (S_2), NPK @ 240-60-60 kg ha^{-1} (S_3) allotted to main plots and seven micronutrient management practices (supplied through foliar feeding) *viz*., Zn @ 0.2% twice at 20 & 40 DAS (F_1), B @ 0.2% twice at 20 & 40

Table 1.Growth parameters of zero till maize as influenced by N levels and micronutrients.

Treatments	Plant height (cm)	DMP (kg ha^{-1})	Days to 50 % tasseling	Days to 50 % silking	*Barren plants (%)
Nitrogen Levels (Soil application)					
S_1: 120:60:60 N, P_2O_5 and K_2O kg ha^{-1}	242.7	18627	75.6	80.2	4.8 (0.7)
S_2: 180:60:60 N, P_2O_5 and K_2O kg ha^{-1}	255.4	21762	75.4	79.0	3.6 (0.4)
S_3: 240:60:60 N, P_2O_5 and K_2O kg ha^{-1}	254.4	24135	75.4	78.8	3.6 (0.4)
S.Em ±	1.1	74.2	0.2	0.3	0.1
CD (P=0.05)	4.5	291.3	NS	1.18	NS
CV (%)	2.1	1.6	1.3	1.8	70.7
Micronutrient management practices (Foliar feeding)					
F_1: Zn @ 0.2% at 20, 40 DAS.	248.4	19412	75.9	79.9	4.4 (0.6)
F_2: B @ 0.2% at 20, 40 DAS	249.4	20982	75.3	79.4	4.4 (0.6)
F_3: Zn+ B @ 0.2% at 20, 40 DAS	251.6	22322	75.3	79.1	4.1 (0.5)
F_4: Mn @ 0.2% at 20, 40 DAS	248.6	19425	75.6	79.6	4.4 (0.6)
F_5: Mn+ B @ 0.2% at 20, 40 DAS	252.1	23439	75.2	78.9	3.1 (0.3)
F_6: Micro nutrient mixture @ 0.2% at 20, 40 DAS	256.7	24481	75.2	78.9	3.1 (0.3)
F_7: Vermiwash at 20, 40 DAS	249.4	20372	75.6	79.7	4.4 (0.6)
S.Em ±	1.3	133.9	0.2	0.3	0.2
CD (P=0.05)	3.8	383.9	NS	NS	NS
CV (%)	1.6	1.9	0.7	1.0	118.2
Interaction (S X F)					
S.Em ±	2.4	227.1	0.3	0.5	0.3
CD (P=0.05)	7.6	677.1	NS	NS	NS

(Data were subjected to arc sine transformation. Figures in parenthesis are original values).

DAS (F_2), Zn and B @ 0.2% twice at 20 & 40 DAS, (F_3), Mn @ 0.2% twice at 20 & 40 DAS (F_4), Mn and B @ 0.2% twice at 20 & 40 DAS (F_5), micronutrient mixture (Fe, Mn, Zn, Cu, Mo and B) @ 0.2% twice at 20 & 40 DAS (F_6) and vermiwash twice at 20& 40 DAS (F_7) allotted to subplots and replicated thrice. The crop was harvested on 27th March, 2015.

RESULTS AND DISCUSSION

EFFECT OF N LEVELS

Significantly taller plants were obtained with S_3 (NPK @ 240-60-60 kg ha^{-1}) which was found parity with S_2 (NPK @ 180-60-60 kg ha^{-1}). The highest dry matter production was noticed with application of NPK @ 240-60-60 kg ha^{-1} (S_3). A progressive enhancement in dry matter production to the tune of 16.8 and 29.6 % was observed at maturity with successive increase in nitrogen level of 180 (S_2) and 240 kg ha^{-1} (S_3) respectively over 120 kg ha^{-1} (S_1). The lowest values for plant height and dry matter production were associated with the lowest dose of N supplied (S_1). Increase in plant height with enhanced levels of nitrogen might be due to the critical role being played by vital macronutrient (N), a key factor responsible for cell division and cell elongation. The increase in plant height and dry matter production with increasing levels of N application obtained in the present investigation was in conformity with the findings of Thimmappa *et al.* (2014) and Venkata Rao *et al.* (2014). Number of days to 50 % flowering and number of barren plants did not altered with increasing levels of N. Significantly lesser number of days required to 50% silking with S_3 (N @ 240 kg ha^{-1})

Yield structure of maize was found to be strongly influenced by incremental levels of nitrogen. Yield attributes of maize *viz.,* cob length, number of kernels cob^{-1}, kernel weight cob^{-1} and test weight were significantly varied with incremental dose of nitrogen. Number of cobs plant^{-1} and number of rows cob^{-1} were not influenced with added levels of nitrogen. The highest cob length and maximum kernel weight cob^{-1} were recorded with application of N @ 240 kg ha^{-1} (S_3)

Table 2. Yield attributes of zero till maize as influenced by N levels and micronutrients.

Treatments	No. of cobs plant^{-1}	Cob length (cm)	No. of rows cob^{-1}	No. of kernels cob^{-1}	Kernel weight cob^{1} (g)	Test weight (g)
Nitrogen Levels (Soil application)						
S_1: 120:60:60 N, P_2O_5 and K_2O kg ha^{-1}	1.2	14.7	15.4	487.1	109.2	22.2
S_2: 180:60:60 N, P_2O_5 and K_2O kg ha^{-1}	1.2	15.8	15.6	510.5	118.4	23.7
S_3: 240:60:60 N, P_2O_5 and K_2O kg ha^{-1}	1.2	16.0	15.6	537.5	123.7	24.4
S.Em ±	0.1	0.1	0.1	3.8	2.2	0.2
CD (P=0.05)	NS	0.5	NS	14.8	8.5	0.6
CV (%)	18.3	4.1	3.2	3.4	8.5	3.2
Micronutrient management practices (Foliar feeding)						
F_1: Zn @ 0.2% at 20, 40 DAS.	1.0	15.1	15.2	489.5	110.9	22.9
F_2: B @ 0.2% at 20, 40 DAS	1.0	15.4	15.5	504.9	116.3	23.2
F_3: Zn+ B @ 0.2% at 20, 40 DAS	1.1	15.6	15.6	517.0	118.4	23.5
F_4: Mn @ 0.2% at 20, 40 DAS	1.0	15.1	15.2	490.6	111.2	23.0
F_5: Mn+ B @ 0.2% at 20, 40 DAS	1.4	15.8	15.8	522.3	121.6	23.9
F_6: Micro nutrient mixture @ 0.2% at 20, 40 DAS	1.7	16.2	16.3	559.1	126.2	24.4
F_7: Vermiwash at 20, 40 DAS	1.1	15.3	15.3	498.3	115.2	23.1
S.Em ±	0.1	0.2	0.2	4.0	3.0	0.3
CD (P=0.05)	0.3	0.5	0.6	11.5	8.6	0.9
CV (%)	29.6	3.8	3.9	2.4	7.7	3.2
Interaction (S X F)						
S.Em ±	0.2	0.3	0.3	7.5	5.3	0.5
CD (P=0.05)	NS	NS	NS	23.5	NS	NS

which was however, found parity with 180 kg N ha^{-1}. Test weight and number of kernels cob^{-1} were maximum with application of 240 kg N ha^{-1}. Significantly lower values for all yield attributes were observed with the lowest level of N @ 120 kg ha^{-1} (S_1). Increased yield attributes with added levels of nitrogen might be due to better kernel filling as a result of increased photosynthetic surface and higher dry matter production. Increased availability of nitrogen to maize at higher levels might have also resulted in the production of longer cobs accompanied by increased kernel filling. These findings are in line with those reported by Thimmappa *et al.* (2014).

The highest kernel and stover yield were obtained with the highest dose of N @ 240 kg ha^{-1} (S_3) while, S_1 (120 kg N ha^{-1}) was found inferior in this regard. Incremental dose of nitrogen increased the kernel yield of maize to the tune of 18.7 and 30.6 % with application of 180 kg N ha^{-1} (S_2) and 240 kg N ha^{-1} (S_3) respectively over the lowest level (120 kg ha^{-1}) of nitrogen supplied. Sufficient and balanced application of nitrogen might have enabled maize crop to produce larger leaf area and higher chlorophyll content both are essential for higher photosynthetic efficiency to assimilate large quantities of photosynthates to kernel which might have contributed to higher kernel yield. These findings are in line with those reported by Thimmappa *et al.* (2014) and Malla Reddy *et al.* (2012).

The highest values for gross returns, net returns and B: C ratio were obtained with the highest dose of N @ 240 kg ha^{-1} (S_3) and the lowest values were recorded with S_1 (120 kg N ha^{-1}).

EFFECT OF MICRONUTRIENT MANAGEMENT PRACTICES

Plant height and dry matter production varied significantly due to micronutrient management practices. Foliar application of micronutrient mixture (F_6) resulted in significantly higher values for plant height and dry matter production. Except F_6, rest of the treatments being on par with each other for plant height while, F_1 (Zn) and F_4 (Mn) were found to produce the lowest

Table 3. Kernel and stover yield as influenced by N levels and micronutrients.

Treatments	Yield (kg ha^{-1})	
	Kernel	Stover
Nitrogen Levels (Soil application)		
S_1: 120:60:60 N, P_2O_5 and K_2O kg ha^{-1}	5589	12301
S_2: 180:60:60 N, P_2O_5 and K_2O kg ha^{-1}	6635	14292
S_3: 240:60:60 N, P_2O_5 and K_2O kg ha^{-1}	7297	16521
S.Em $\pm$	122.76	113.52
CD (P=0.05)	481.99	445.7
CV (%)	8.65	3.62
Micronutrient management practices (Foliar feeding)		
F_1: Zn @ 0.2% at 20, 40 DAS.	5718	13620
F_2: B @ 0.2% at 20, 40 DAS	6428	14298
F_3: Zn+ B @ 0.2% at 20, 40 DAS	6713	14553
F_4: Mn @ 0.2% at 20, 40 DAS	5991	13634
F_5: Mn+ B @ 0.2% at 20, 40 DAS	6972	14997
F_6: Micro nutrient mixture @ 0.2% at 20, 40 DAS	7470	15386
F_7: Vermiwash at 20, 40 DAS	6256	14112
S.Em $\pm$	146.2	172.1
CD (P=0.05)	419.3	493.5
CV (%)	6.7	3.6
Interaction (S X F)		
S.Em $\pm$	264.6	298.3
CD (P=0.05)	819.2	901.3

dry matter. Number of days to 50 % tasseling and silking and number of barren plants did not altered due to micronutrient management practices.

Yield attributes *viz.,* no. of cobs $plant^{-1}$, no .of rows cob^{-1}, length of cob and test weight were significantly higher due to application of micronutrient mixture (F_6) which was however, on par with F_5 (Mn and B). Significantly higher no .of kernels cob^{-1} was registered with F_6. Maximum kernel weight cob^{-1} was also recorded with F_6 which was however, on par with F_5 (Mn and B) and F_3 (Zn and B). The lowest values for no. of cobs $plant^{-1}$, length of cob, kernel weight cob^{-1} and test weight were associated with F_1, F_2, F_3, F_4 and F_7, all are being on par with each other which in turn were on par with F_5 (Mn and B) in case of number of rows cob^{-1}. Minimum number of kernels cob^{-1} was noticed with F_1 (Zn) which was however, comparable with F_4 (Mn) and F_7 (vermiwash). Significantly higher values for all the yield attributes were associated with the application of micronutrient mixture (F_6) that contains six essential elements, very crucial for triggering a series of physiological processes which might have enhanced the yield structure of maize. Increased supply of large number of micronutrients might have also involved in enhancing the reproductive potential of maize especially increased pollen viability, fertilization, kernel filing *etc*. The possibility of enhanced yield structure at various micronutrient elements was documented by number of earlier researchers (Usha and Joy 2013 and Azhar *et al*., 2011).

Maximum kernel and stover yield were recorded with foliar application of micronutrient mixture (F_6) which was however, on par with F_5 in case of stover yield. There was an impressive progress in the kernel yield of zero till maize to the magnitude of 30.64 % with the application of micro nutrient mixture (F_6) compared to application of Zn alone (F_1). The lowest kernel yield was obtained with F_1 and F_4, which were however, on par with F_7 (vermiwash) for stover yield. The clear cut superiority of F_6 (micronutrient mixture) over rest of the micronutrient management practices in enhancing kernel yield of maize could be ascribed to the balanced nutrition including bulk of the micronutrients (six) supplied through foliar feeding.

Table 4: Gross returns, net returns and B: C ratio of zero till maize as influenced by N levels and micronutrients.

Treatments	Returns (Rs. ha^{-1})		B:C ratio
	Gross	Net	
Nitrogen Levels (Soil application)			
S_1: 120:60:60 N, P_2O_5 and K_2O kg ha^{-1}	87185	47172	1.2
S_2: 180:60:60 N, P_2O_5 and K_2O kg ha^{-1}	103353	62600	1.5
S_3: 240:60:60 N, P_2O_5 and K_2O kg ha^{-1}	114067	72573	1.8
S.Em $\pm$	1793.9	1793.3	0.04
CD (P=0.05)	7042.9	7042.9	0.2
CV (%)	8.1	13.5	13.2
Micronutrient management practices (Foliar feeding)			
F_1: Zn @ 0.2% at 20, 40 DAS.	89716	49204	1.2
F_2: B @ 0.2% at 20, 40 DAS	100350	59583	1.5
F_3: Zn+ B @ 0.2% at 20, 40 DAS	104615	63234	1.5
F_4: Mn @ 0.2% at 20, 40 DAS	93693	52925	1.3
F_5: Mn+ B @ 0.2% at 20, 40 DAS	108594	66957	1.6
F_6: Micro nutrient mixture @ 0.2% at 20, 40 DAS	116005	75746	1.9
F_7: Vermiwash at 20, 40 DAS	97773	57824	1.4
S.Em $\pm$	2118.5	2118.5	0.05
CD (P=0.05)	6075.9	6075.8	0.1
CV (%)	6.3	10.5	10.3
Interaction (S X F)			
S.Em $\pm$	3841.7	3841.7	0.09
CD (P=0.05)	11904.4	11904.4	0.3

These findings are in line with those reported by Azhar *et al*. (2011).

Maximum values for gross returns, net returns and B: C ratio were noticed with foliar application of micronutrient mixture (F_6) while, the lowest values were recorded with F_1 (Zn) which were however, comparable with F_4 (Mn).

INTERACTION EFFECT:

Growth parameters *viz*., plant height and dry matter production significantly varied due to interaction between N levels and micronutrient management practices. The highest plant height observed with S_3 (240 kg N ha^{-1}) at F_6 (micronutrient mixture) which was however, on par with F_5 (Mn and B) and F_4 (Mn) at same level of N (S_3), F_5 and F_1 (Zn) at S_2 (180 kg N ha^{-1}) and F_6 at S_1 (120 kg N ha^{-1}). Maximum dry matter production was noticed with S_3 at F_6. Enhanced dry matter accumulation at higher levels of nitrogen application and supplemented with large number of micronutrients might be due to the positive and balanced influence that was created at the ecorhizosphere of maize which might have enable the crop to absorb required quantities of mineral nutrition and promoted greater opportunity to enhance photosynthetic surface, greater chlorophyll content, enhanced internodal length; all contributed to large dry matter accumulation. Enhanced plant height and dry matter production with added levels of nitrogen and supplemented with micronutrients has been an undisputed fact and universally acceptable proposition as could be visualized from a widely documented evidence (Thimmappa *et al*., 2014, Usha and Joy, 2013 and Malla Reddy *et al.,*2012).

Yield attributes *viz.,* no. of cobs $plant^{-1}$, no. of rows cob^{-1}, length of cob^{-1}, kernel weight cob^{-1}, and test weight were not altered significantly due to interaction between N levels and micronutrient management practices. While, the no .of kernels cob^{-1} was found to alter significantly. The highest no .of kernels cob^{-1} was recorded with S_3 (240 kg N ha^{-1}) at F_6 (micronutrient mixture). The possibility of enhanced yield structure at higher level of nitrogen when supplemented with large quantities of vital micronutrient elements was documented by number of earlier researchers (Usha and Joy, 2013 and Azhar Ghaffari *et al*., 2011).

Significantly higher values for kernel yield of zero till maize was registered with the highest level of nitrogen tried (240 kg ha^{-1}) and supplemented with foliar feeding of micro nutrient mixture (F_6) which was however, found parity with F_5 (Mn and B), F_3 (Zn and B) at the same level of nitrogen and F_6 at 180 kg N ha^{-1} (S_2). Kernel yield was minimum with foliar application of Zn alone (F_1) at the lowest level of nitrogen supplied (120 kg ha^{-1}). The highest stover yield was obtained with S_3 at F_6. Supplementation of multi micronutrients through foliar feeding in the presence of sufficient quantities of macro nutrient elements during the peak physiological requirements of maize might have helped in formation of a congenial nutriophysiology to produce huge kernel yield. Also, increasing demand for micronutrients in the presence of sufficient and balance amounts of major nutrients might have relieved the crop from hidden hunger for micronutrients due to their supplementation at appropriate intervals during the peak period of crop growth and resulted in better performance of the crop in terms of growth, yield attributes and yield.

The synergism between the highest level of nitrogen supplied to maize crop and supplemented with foliar feeding of a mixture of micronutrients was very much reflected in this study. Either additive or synergistic interaction effect at higher level of nitrogen when supplemented with foliar feeding of micronutrients is quite common in crops like maize having elevated yield potential. Similar views were also expressed by Thimmappa *et al.* (2014), Malla Reddy and Padmaja (2014), Usha and Joy, (2013) and Azhar *et al.* (2011) which are in conformity with the present investigation.

The highest gross and net returns were obtained with S_3 (N @ 240 kg ha^{-1}) at F_6 (micronutrient mixture) which was however, on par with F_5 (Mn and B) at the same level of N and S_2 (N @ 180 kg ha^{-1}) at F_6. While, the lowest values were recorded with S_1 (N @ 120 kg ha^{-1}) at F_1 (Zn) .With respect to B: C ratio, maximum values were recorded with S_3 at F_6 which was however, found parity with same micronutrient management practice at immediate lower dose of N (S_2). The lowest B: C ratio with S_1 at F_1**.**

In conclusion, the study revealed that zero till maize can be grown successfully in North Coastal Zone of Andhra Pradesh with application of 180 kg N ha^{-1} and supplemented with foliar feeding of micronutrient mixture 0.2 % twice at 20 & 40 DAS which was found the most optimum and cost-effective dose to realize the best yields from zero till sown maize in North Coastal Zone of Andhra Pradesh as indicated by realization of higher grain yield, gross and net returns as well as B: C ratio.

LITERATURE CITED

Azhar Ghaffari, Asghar Ali, Muhammad Tahir, Muhammad Waseem, Muhammad Ayub, Asif Iqbal and Atta Ullah Mohsin 2011 Influence of integrated nutrients on growth, yield and quality of maize (*Zea mays* L.). *American Jouirnal of Plant Sciences,* 2: 63 – 69.

Malla Reddy and Padmaja. 2014. Productivity and water use efficiency of no-till winter (*rabi*) maize (Zea *mays* L.) as influenced by drip fertigation. *Indian Journal of Agronomy,* 59(1):96-100.

Malla Reddy M, Padmaja B and Vishnu vardhan Reddy D 2012 Response of Maize (*Zea mays* L.) to irrigation scheduling and nitrogen doses under no till condition in rice fallows. *Journal of Research ANGRAU,* 40(1):6-12.

Thimmappa V, Srinivasa Reddy M, Vijaya Bhaskar Reddy U and Tirumala Reddy S 2014 Effect of nitrogen levels and plant densities on growth parameters, yield attributes and yield of *kharif* maize (*Zea mays* L.) *Crop Research*, 47 (1, 2 & 3):29-32.

Usha Kiran, K and Joy Dawson 2013 Influence of nutrient sources on growth and yield of maize (*Zea mays* L.) CV. DMH 123.*Society for Science Development in Agriculture and Technology,* 8:203-204.

(Received on 20.07.2015 and revised on 22.01.2016)