IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS)
ISSN (P): 2347-4580; ISSN (E): 2321-8851
Vol. 5, Issue 8, Aug 2017, 19-26

RESPONSE OF MAIZE (ZEA MAYS, L.) GRAIN YIELD AND RATIO TO THE NUTRIENTS APPLICATIONS DURING RABI IN TELANGANA STATE

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ABSTRACT

Investigations were carried out on the Response of Maize (Zea mays L.) Grain yield (kg/ha) and ratio (kg/kg) to the nutrient applications in Telangana state (Soil Test Crop Response Correlation) during 2008 and 2009 at Regional Agricultural Research Station, Warangal. The experiment was conducted at different sites adjacent to each other on a sandy clay loam soil having a low status in available nitrogen (272kg/ha) in the first year and medium (323kg N/ha) in the second year. The soil available phosphorus had a medium status with 60 kg P_2O_5/ha in the first year and 50. Kg P_2O_5/ha in the second year. It was rich in available potassium having 719 and 829 kg K_2O/ha during the corresponding years. The yield response, increased with the application of fertilizer up to 240 kg N/ha in the three strips during both the years. A mean maximum yield response of 3150 kg /ha grain yield was obtained by the application of 240 kg/ha in 0X fertility gradient. A mean maximum yield response of 1587 kg/ha was also obtained by the application of 120 kg P_2O_5g/ha in this fertility gradient. The maximum response of 577 kg grain yield was obtained by the application of 120 kg K_2O/ha in the 1 X fertility gradient. The response ratio was also altered by the level of fertilizer and fertility gradient. Mean maximum yield response ratio was 13.12 kg grain/kg N at 240 kg N/ha and 13.22 kg grain/kg P at 120 kg P_2O_5/ha in the 0 X fertility gradient. But the mean maximum response ratio of 4.81 kg/kg K was obtained by the application of 120 kg K_2O/ha in 1 X fertility gradient.

KEYWORDS: NPK nutrient response, maize grain yield and yield ratio

INTRODUCTION

The poor management level in farmer's fields is also one of the important reasons for low fertilizer use efficiency and low yield of maize. Balanced and efficient use of fertilizers is the key step to lower the unit production cost, increase the economic returns and minimize the negative environmental impact. The efficiency of the added fertilizers depends upon many factors like nature of the soil, availability of nutrients, the climate, crop and its variety, management practices used as a promising tool to evaluate the nutrient supplying capacity of the soil and the nutrient requirement of crop. The fertilizer requirement of different crops varies due to their differential production potential, ability to draw the mineralized soil nutrients and their additions through the fertilizers. Farmers in the Central Telangana Zone of Andhra Pradesh seldom follow the recommended dose of 120:60:50 N P K kg/ha. The fertilizer application is indiscriminate. The fertility status of the soil for N P K is highly variable from field to field. Therefore, dose of fertilizer recommendation is not precise for all the fields. The quantitative approach based on the rating of soil available N P K in the low, medium and high categories is also beset with similar.

MATERIALS AND METHODS

The experiment was conducted at the Regional Agricultural Research Station, Warangal, Telangana State entitled Soil Test Crop Response Correlation Studies in Maize (Zea mays L.) one of the objective is Response of Maize (Zea mays L.) grain yield(kg/ha) and ratio (kg/kg) to the nutrients applications during Rabi 2008 and 2009. The experimental site is geographically located at 18°03′ N latitude and 79°22′ E longitude at an altitude of 270 m above the mean sea level. The experiments were conducted at two different sites in the two years adjacent to each other by about 15 m. Composite soil sample was drawn from 0 to 30 cm depth from different spots. It was analyzed for different physico–chemical properties by adopting standard procedures.. The soil was sandy clay loam in texture. It had an alkaline reaction having a pH of 8.10 during 2007 and 8.37 during 2008. There was no problem of salt accumulation in either of the two years. There was a low organic carbon content of 0.47per cent in the first year and 0.40 per cent in the second year. The fertility status in terms of available nitrogen was different. In the first year, it had a low status with 272.34 kg N / ha while it was medium with 323.67 kg N / ha in the subsequent year. The status of phosphorus was medium with 60 kg P_2O_5/ ha in the first year and 50 kg P_2O_5/ha in the second year. It was very rich in potassium. The available quantity of K_2O was 719 kg / ha in the first year and 829 kg / ha in the second year. The field was divided into three strips as O X, 1 X and 2 X Each strip were divided into 24 plots measuring 7.0 x 7.8 m. These plots were separated by bunds measuring 45 cm and alternated by feeder channels of 75 cm for irrigation

Table 1: The Treatments were a Combination of Four Levels of Each N, P and K

Nitrogen (kg N/ha)	Phosphorus (kgP_2O_5/ha)	Potassium(kg K_2O/ha)
N_0-0	P_0-0	K_0-0
N_1-80	P_1-40	K_1-40
N_2-160	P_2-80	K_2-80
N_3-240	P_3-120	K_3-120

A set of 21 treatments comprising the combined levels of NPK and 3 unfertilized controls were randomly allocated in each fertility gradient strip for soil test crop response experiment in accordance with the recommendation by the All India Coordinated Research Project on soil test crop response correlation studies (www.iasi, res.in). The fertilizers were applied to the plots as per the treatments. One third of nitrogen and full dose of phosphorus and potassium were applied as a basal dose and remaining nitrogen was applied as top dressing at 40 days after sowing and teaseling stage. The crop was irrigated at the time of sowing and remaining six irrigations were given at 25, 40, 55, 70, 85 and 95 days after sowing

Yield Response to Nutrients (Kg/Ha)

The yield response to N, P and K application was derived, by comparing pairs of treatments with and without a nutrient at same level of the other two nutrients. For example, with yields of N 240 – P80 – K80 and N160 – P80 – K80 treatments, which are at same level of P and K, the response to N at 80 kg/ha could be derived as the yield difference of the two treatments. Such type of comparisons are derived for N at 80, 160 and 240 kg/ha in 0 X, 1 X and 2 X gradients and are averaged for each level from pairs of treatment comparisons. The responses to P were also derived by comparing treatments with and without P at same level of N and K and the responses are averaged. A similar response analysis of K is

made by comparing with and without K at same level of N and P treatments and is averaged for each level of K.

$$\left[\begin{array}{l}\text{Response to N at given level (at same P and K levels)}\end{array}\right] = \left[\begin{array}{l}\text{Yield for treatment with higher N and a given P and K}\end{array}\right] - \left[\begin{array}{l}\text{Yield for treatment with lower N and given P and K}\end{array}\right]$$

Example:

N response at	=	Yield	-	Yield
N= 80 kg/ha		(N 240 P120 K120)		(N160 P120 K120)
P response at	=	Yield	-	Yield
P = 40 kg/ha		(N80 P80 K40)		(N80 P40 K40)
K response at	=	Yield	-	Yield
K=40 kg/ha		(N160 P80 K40)		(N160 P80 K80)

Yield Response Ratio (Kg/Kg)

This was obtained as the quotient of additional yield obtained by the application of a given level of nutrient i.e. yield kg/kg nutrient

Additional yield over control

$$\text{Yield response ratio} = \frac{\text{Additional yield over control}}{\text{The quantity of nutrient applied}}$$

RESULTS AND DISCUSSIONS

Grain Yield (Q/Ha)

The crop produced mean seed yield of 3884 kg /ha in the O X fertility strip and 3859 kg /ha in the 1 X fertility strip during the first year. The production increased to 4257 kg /ha in the 2 X strip. The yield increased consistently with improvement in the level of fertility gradient in the second year. The crop produced 2488 kg /ha grain yield in the O X fertility gradient without the application of nitrogen during the first year. The yield increased to 2868 and 4239 kg /ha by the application of 80 and 160 kg N/ha and further to a maximum of 5287 kg /ha in response to the addition of 240 kg N/ha in the first year. Similar yield increments were recorded with increase in fertilizer dose up to 240 kg N/ha in 1 X and 2 X fertility gradients. But, the production was more in the 2 X fertility gradient strip at each level of fertilizer nitrogen than in the O X and 1 X strips. The crop also produced low yield of 2789 kg /ha in the O X strip without the application of nitrogen in the second year. The yield increased to 4236 and 5104 kg /ha by the application of 80 and 160 kg N/ha and further to 5900 kg /ha by the application of 240 kg N/ha. The response was relatively better in the 1 X strip at 0, 80 and 160 kg N/ha than in O X. But, the crop invariably produced more grain yield in the 2 X strip at each of the four levels of

nitrogen. The application of phosphorus at 120 kg P_2O_5/ha maximized the grain yield of maize to 5308, 4921 and 5498 kg /ha in the O X, 1 X and 2 X fertility gradient strips during the first year. The crop produced more grain yield at each of the four levels of phosphorus application in 2 X than 1 X or O X fertility strip. Maize also responded to the application of phosphorus in the three fertility strips. The crop raised in 2 X fertility strip produced more grain yield at each level of K both during 2008and 2009.

Grain Yield Response (Kg/Ha) of Maize to the Nutrients Applied

The yield response of maize to different levels of fertilizers was highly variable in the three fertility gradients (Table 2). The response to increasing level of nitrogen was spectacular up to 80 to 240 kg N/ha in the three fertility gradient strips during 2008 and 2009. The crop was most responsive in the 1 X fertility gradient in the first year and in the O X gradient in the second year due to the application of 240 kg N/ha. The mean response was 3150 kg/ha grain yield due to the application of 240 kg N/ha in the O X strip.

The application of phosphorus was also required up to 120 kg P_2O_5/ha in the O X fertility gradient during the two years. The crop produced additional yield of 1341 kg/ha in the first year, 1832 kg/ha in the second year and a mean of 1587 kg/ha by the application of 120 kg P_2O_5/ha in the O X fertility gradient. The response to phosphorus application diminished in the 1 X fertility gradient.

The need for application of potassium was recognized in the 1 X and 2 X fertility gradients. The crop needed 120 kg K_2O/ha to increase the production of maize substantially. The mean response was 385 kg/ha in the 1 X and 303 kg/ha in 2 X fertility gradient by the application of 120 kg K_2O/ha in the first year. The response was 769 and 183 kg/ha in the respective fertility gradient during the second year. The mean response was 577 and 243 kg/ha in the corresponding fertility gradients.

The grain yield response of maize increased with increase in the level of fertilizer up to 240 kg N/ha during the two years. This was more prominent in the O X fertility gradient. The mean response was 3150 kg in the O X, 2313 kg/ha in the 1 X and 1815 kg/ha in the 2 X fertility gradient due to the application of 240 kg N/ha. This indicated that the fertilizer was utilized more efficiently in the soil having relatively low level of nitrogen. Such a need to fertilize the crop with high level of the nutrients to harvest more grain yield were also reported by several workers (Kumar et al, 2005, Singh and Singh 2006, Bindhani et al, 2007, Kumar et al, 2007, Sahoo and Mahapatra 2007, Singh and Choudhary, 2008, Marihus Altoe Shamie Zingore 2011, Baldotto et al, 2012, Aduloju and Abdulmalik 2013, Amanullah et al, 2014, Ahazimkoma, 2015)

Response Ratio (Kg/Kg) of Maize Yield to Fertilizer Application

The data on yield response per kg of nutrient application to the crop showed different responses in the three fertility gradients (Table 3). The response to application of nitrogen was invariably more in the O X than in the 1 X or 2 X fertility gradients during 2008 and 2009. Maximum response of 13.54 kg grain/kg N was recorded by the application of 80 kg N/ha in the O X fertility gradient during 2008. The maximum response was 16.40 kg grain/kg N applied at a high dose of 240 kg N/ha in the O X fertility gradient during 2008. The maximum mean response was 13.12 kg grain/kg N in the O X fertility gradient.

The beneficial effect of phosphorus application was also recorded in the O X fertility gradient than in the 1 X or 2

X gradients during the two years. A high response of 14.18 kg grain/kg P application was recorded by the application of 40 kg P_2O_5/ha in the O X fertility gradient during first year. The response increased at high dose of phosphorus application in the O X fertility gradient in the second year. Maximum yield response of 15.27 kg grain/kg P was recorded by the application of 120 kg P_2O_5/ha, The mean response ranged from 11.56 to 13.38 kg grain/ kg P at fertilizer application rate ranging from 40 to 120 kg P_2O_5/ha.

The response to application of potassium was positive in the 1 X and 2 X fertility gradient during the first year. Maximum yield response of 4.08 kg grain/kg K was recorded by the application of 40 kg K_2O/ha in the 1 X fertility gradient. High yield response of 6.41 kg grain/kg K was obtained by the application of 120 kg K_2O/ha and 4.69 kg /kg by the application of potassium at 80 kg K_2O/ha in the 1 X fertility gradient during 2009.

The mean response ratio was also maximum in the O X fertility gradient due to the application of 240 kg N/ha. Phosphorus was best utilized in the O X fertility gradient at high level of 120 kg P_2O_5/ha. The mean yield response was 1587 kg/ha and the response ratio was 13.22 kg grain/kg P. The need for potassium was recognized up to 120 kg K_2O/ha in the 1 X and 2 X fertility gradients. The soil was rich in soil available K. Hence, maize did not respond to its application in the O X fertility gradient. However mean maximum yield response of 577kg/ha was recognized in the 1 X and 243 kg/ha in the 2 X fertility gradient by the application of 120 kg K_2O/ha. The response ratio was 4.81 and 2.03 in the respective fertility gradients. This positive response in the 1 X and 2 X fertility gradient was due to the availability of relatively more quantity of N and P which promoted crop vigor to draw more N P K from the soil and thereby respond to the fertilizer application.

CONCLUTIONS

The maize yield response to applied nutrients showed considerable differences in the three fertility gradients. The yield increased with successive increase in the level of fertilizer up to 240 kg N/ha. Maximum response to this level was recorded in the crop grown in the 1 X fertility gradient during 2008 and O X fertility gradient during 2009.

The mean response was 3150 kg grain/ha by the application of 240 kg N/ha in the O X fertility gradient. Mean maximum response of 1587 kg grain yield/ha was obtained by the application of 120 kg P_2O_5/ha in the O X fertility gradient. The mean response to potassium was maximized to 577 kg/ha by application of 120 kg K_2O/ha in 1 X fertility gradient. The response ratio of maize grain/kg of nutrient addition exhibited little differences due to different levels of fertilizer nitrogen in the three gradients during the first year. But the response ratio to different levels of N application was much higher in the O X fertility gradient during the second year. Maximum mean response ratio of 13.12 kg grain/kg N was obtained by the application of 240 kg N/ha to maize in the O X fertility gradient. Mean high response ratio of 13.38 and 13.22 kg grain/kg P_2O_5 was obtained by the application of 80 and 120 kg P_2O_5/ha. The response ratio was very low due to the application of potassium Maximum response ratio of 4.81 kg grain/kg K_2O was realized by the application of 120 kg/ha K_2O in 1 X fertility gradient.

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Table 2: Grain Yield (Kg /Ha) of Maize as Influenced by Different Levels of Fertilizers

Treatment	Rabi 2007-08			Rabi 2008-09		
	0 X	1 X	2 X	0 X	1 X	2 X
N0	2488	2052	2885	2789	3835	4140
N80	2868	3402	3610	4236	5657	5843
N160	4239	4204	4593	5104	5765	5994
N240	5287	5195	5396	5900	5870	6515
P0	2717	2496	3154	3087	4128	4369
P40	3691	4117	3996	4682	5634	5802
P80	4073	4085	4500	5037	5740	6090
P120	5308	49.21	5498	5843	5773	6418
K0	2874	2463	3236	3591	4096	5586
K40	4313	4343	4558	5050	5873	6065
K80	3985	3926	4324	4636	5535	6010
K120	4760	5108	5331	5976	5909	6342
Mean	3884	3859	4257	4661	5318	5765
SD	9.78	10.54	8.99	10.64	7.93	7.54
CV%	25.18	27.32	21.11	22.83	14.91	13.09

Table 3: Yield response (kg/ha) of maize as influenced by different levels of fertilizers

Treatments	Rabi 2007-08			Rabi 2008-09			Mean		
	0 X	1 X	2 X	0 X	1 X	2 X	0 X	1 X	2 X
N80	1083	939	766	862	90	428	973	514	597
N160	1969	1461	1434	1694	453	710	1832	957	1072
N240	2362	2749	2165	3937	1877	1465	3150	2313	1815
P40	567	-6	510	358	-105	255	463	-56	382
P80	858	-155	665	1282	516	196	1070	181	430
P120	1341	-379	892	1832	-495	311	1587	-437	602
K40	-100	163	89	51	-105	161	-24	29	125
K80	-152	164	287	298	375	91	73	270	189
K120	-748	385	303	-92	769	183	-420	577	243