International Journal of Science, Environment and Technology, Vol. 13, No 3, 2024, 190 - 196
ISSN 2278-3687 (O)
2277-663X (P)

IMPACT OF SOIL TEST BASED FERTILIZER APPLICATION ON YIELD AND ECONOMICS IN MAIZE

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Abstract: Frontline demonstrations were carried out to study the soil test-based fertilizer application on yield, soil health and economics in Maize during the kharif seasons of 2019, 2020 & 2021 in farmers' fields of Kurnool district of Andhra Pradesh. The demonstrations conducted in ten locations revealed that application of nitrogen, phosphorus and potassium based on soil test values resulted in an average yield increase of 8.53 percent over the farmer's practice. Demonstration plots recorded an average B:C ratio of 2.82 against farmers' practice of 2.2 and the technology index reduced from 4.5 to 2.57 percent. The organic carbon content increased from 0.35% to 0.40 % due the application of farmyard manure based on soil test value. The soil test based fertilizer application resulted in higher yield, net returns, B:C ratio and organic carbon content and low technology index indicates the feasibility of technology to adopt at farmers' level.
Keywords: Maize, Soil test based fertilizer application, Technology gap, Extension gap, Technology index

INTRODUCTION

Maize is a crop that can grow in a variety of agro-climatic conditions and is farmed all year round in India. Because it has the highest genetic yield potential among cereals, maize is known as the "Queen of Cereals". As the third most significant cereal crop in India after rice and wheat, maize accounts for roughly 10% of all food grain production. India's maize acreage has grown to 9.86 million hectares during 2020–21, producing 31.51 million tonnes at a productivity of 3195 kg ha^{-1}. (Choudhari *et al.*,2023). In recent years, nitrogen has become the fertilizer most in-demand in India, with phosphorus coming in second. Due to this, the NPK utilisation ratio in 2019–20 was severely out of balance, coming in at 7:2.7:1, as opposed to the ideal ratio of 4:2:1. (Chander *et al.*,2019). Fertilizers are one of the costliest inputs in agriculture and the use of the right amount of fertilizer at the right time is fundamental for farm profitability and environmental protection (Kimetu *et al.*, 2004). Imbalanced use of fertilizers directly or indirectly causes adverse changes in soil properties and these changes are believed to have significant influences on the quality and productive

*Received April 30, 2024 * Published June 2, 2024 * www.ijset.net*

capacity of the soil. According to FAO (2005), there is a gap of about 10 million tonnes of N, P, K nutrients between the crop removal and replenishment through fertilizers. To narrow down this gap, balanced use of fertilizers is the most imperative aspect and fertilizer application based on soil testing is being advocated throughout the world. Through soil testing, nutrients status and their imbalances are known so that the required amount of the nutrients to overcome imbalances can be applied. Though awareness of the importance of soil health and soil testing is gaining momentum, many are not unaware of test results interpretation and use of soil test based fertilizer (STBF) application. The major constraints involved difficulty in understanding of soil testing, delay in getting the test reports, difficulty in following test based fertilizer recommendation, uncertainty in yield gain and lack of proper and scientific guidance. (Patel et.al.*,2019)*. At this backdrop, Krishi Vigyan Kendra, Banavasi conducted front line demonstrations to create awareness and to impart knowledge on soil test based fertilizer application in cultivation of Maize to reduce the indiscriminate and excessive use of fertilizers, reduction of cost of cultivation and to minimise the soil pollution**.**

METHODOLOGY

Krishi Vigyan Kendra, Banavasi, carried out ten frontline demonstrations in the farmers' fields during *kharif* season from 2019 to 2021 in the three mandals *viz.*, Yemmiganur, Adoni, and Kodumuru of Kurnool District in Andhra Pradesh. The necessary steps for selection of site and layout of demonstrations etc. were followed as suggested by Choudhary (1999). Soil fertility of the selected plots was analyzed before and after the demonstrations. Samples were analyzed for organic carbon by Walkey and Black method (1934), available nitrogen by alkaline potassium permanganate method as proposed by Subbaiah and Asija (1956), available phosphorus by Olsen's method by Olsen *et al*, (1954) and available potassium by ammonium acetate method as described by Jackson (1973). The samples analyzed were found to be low in nitrogen content, high in phosphorus and medium in potassium content. Based on soil test values 300, 60 and 80 kg/ha of nitrogen, phosphorus and potassium were applied respectively in demonstration plots. The general trend of application fertilizers in farmers practice is 310 kg of nitrogen, 150 kg of phosphorus and 75 kg of potassium and 19.5 kg of sulphur. For each demonstration a plot of 0.8 ha was selected and divided into two parts of each 0.4 ha. Sub plots were allotted with T1 (plots receiving N, P, K fertilizers based on soil test values) and T2 (plots receiving fertilizers as per farmers practice). Maize hybrid PAC-351 was sown during 2^{nd} to 3^{rd} week of August and harvested during 1^{st} to 2^{nd} week of December in all the years. The data were collected both from the demonstrations as well as check plots. The input and output of the commodities prevailing during the study were taken into an account for calculating the net returns and benefit-cost ratio. The extension gap, technology gap and technology index (Samui et al., 2000) were calculated using the following equation:

Technology gap = Potential yield – demonstration yield

Extension gap = Demonstration yield - farmers practice yield

$$\text{Technology index (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

RESULTS AND DISCUSSION

The soil test data indicates that the organic carbon percentage in soil gradually increased from 0.35% to 0.40 % from 2019 to 2021 (Fig. 1). This increase in organic carbon content which ultimately results in improvement of soil health might be due to application of 12.5 t ha^{-1} of farmyard manure based on soil test value and also acceleration of microbial activity with balanced use of chemical fertilizers instead of indiscriminate use. Combination of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility. Thus, the balanced use of fertilizer either alone or in combination with FYM is necessary for sustaining soil fertility and productivity of crop. Similar findings were reported in Rice by Jayalakshmi *et al.* (2021).

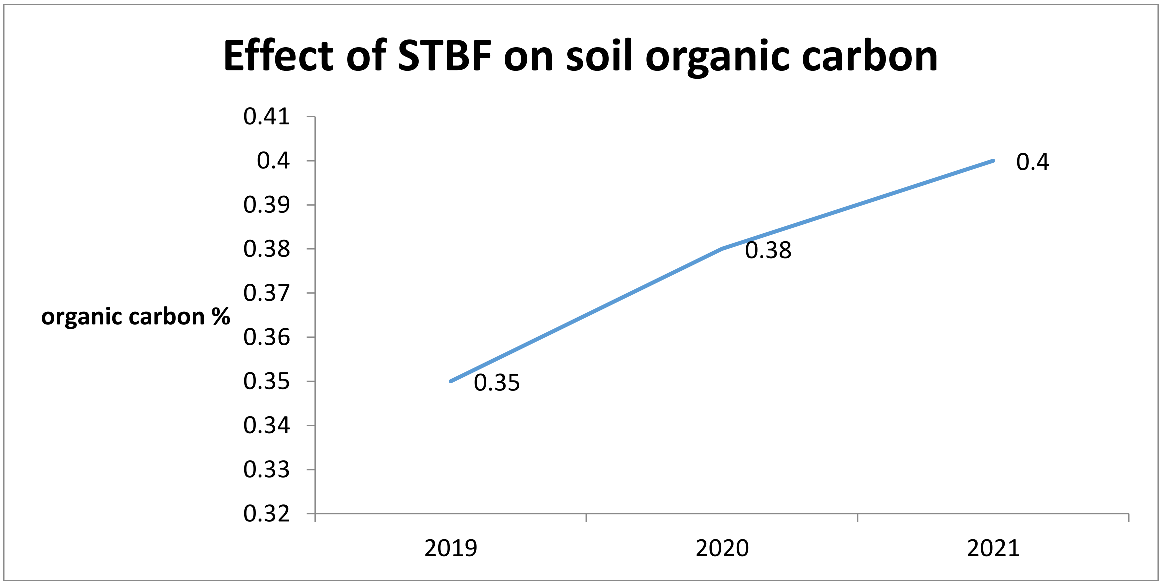

Fig. 1. Effect of STBF on soil organic carbon

Table 1: Effect of on soil test based fertilizer application on yield and economics of Maize

	Grain yield (kg/ha)		Percent increase in yield over farmers practice (FP)	Cost of cultivation (Rs./ha)		Net Returns (Rs./ha)		B:C Ratio	
	STBF	**F.P**		**STBF**	**F.P**	**STBF**	**F.P**	**STBF**	**F.P**
2019	6800	6200	9.68	45300	53550	90700	70450	3.00	2.32
2020	6850	6300	8.73	48950	58850	88050	67150	2.80	2.14
2021	6700	6250	7.20	50150	58250	83850	66750	2.67	2.15
Average	6783	6250	8.53	48133	56883	87533	68117	2.82	2.20

Perusal of the data presented in Table 1. revealed that the average grain yields of maize were higher with soil test based application fields with 6800, 6850 and 6700 kg ha^{-1} during 2019, 2020 and 2021 respectively than farmers practice yields of 6200, 6300 and 6250 kg ha^{-1} during 2019, 2020 and 2021 respectively. Percent increase in yield over farmers' practice was 9.68, 8.73 and 7.2 in 2019, 2020 and 2021 respectively. These higher yields might be due to balanced application of nitrogen, phosphorus and potassium in the demonstrations. In farmers practice due to application of phosphorus and sulphur by top dressing of complex fertilizers resulted in excessive build up of phosphorus and sulphide injury in deep black soils of Kurnool. These results are also in accordance with Jayalakshmi *et al.* (2021). Higher net returns of Rs. 90,700 ha^{-1}, Rs. 88,050 ha^{-1} and Rs. 83,850 ha^{-1} were recorded during *kharif 2019*, 2020 and 2021 respectively with soil test based application as compared to Rs. 70,504 ha^{-1}, Rs. 67,150 ha^{-1} and Rs.66,750 ha^{-1} during *kharif* 2019, 2020 and 2021 respectively in the farmers practice. The higher net returns in demonstration might be due to higher yields and reduced cost on fertilizers due to application of straight fertilizers for top dressing as against the farmers' practice where complex fertilizers were used for top dressing resulted in increased cost of cultivation. The benefit-cost ratio of Maize cultivation with soil test based fertilizer application was 3.0, 2.80 and 2.67 during *kharif 2019*, 2020 and 2021, respectively compared to 2.32, 2.14 and 2.15 under farmers' practice. This might be due to higher returns and reduced cost of cultivation in soil test based fertilizer application as compared to farmers practice. This finding was conformity with the findings of Jayalakshmi et.al by a study conducted in rice (2021).

Extension gaps of 3.8, 1.9 and 2.5 q/ha were observed during *kharif* 2019, 2020 and 2021 respectively (Table 2). Extension gap emphasizes the need to bring awareness among the farmers for adoption of soil test based fertilizer application and to harvest the trend of wide extension gap. This extension gap may be due to difficulty in calculating the dosages of fertilizers according to soil test results. This results also in accordance with Ghaswa et. al by the study conducted in Ratlam district of M.P (2019).

Results also indicated a technology gap between the soil test based fertilizer application and farmers practice in tune of 2.8, 2.2 and 1.0 q ha^{-1} during *kharif* 2019, 2019 and 2020 respectively. The technology gap observed may be attributed to differences in soil type and cultivation practices and may be overcome by adoption of soil test based fertilizer application along with best management practices. A similar finding was reported by S.K Singh et.al (2019).

Table 2: Effect of Soil test based fertilizer application on Technology gap, Extension gap and Technology index

	Extension gap (q/ha)	**Technology gap (q/ha)**	**Technology index (%)**
2019	3.8	2.8	4.50
2020	1.9	2.2	3.93
2021	2.5	1.0	2.57

The technology index indicates the feasibility of the evolved technology at the farmers' fields. Lower the values of technology index more is the feasibility of the technology demonstrated (Chauhan 2011). The technology index in the present study was 3.84, 3.07 and 1.53 percent during *kharif* 2019, 2020 and 2021 respectively showing the efficacy of good performance of soil test based fertilizer application. The reduction in the technology index from 4.50 to 2.57 percent during *kharif* 2019 to 2021 exhibits the feasibility of the soil test based fertilizer application.

CONCLUSION

By executing front-line demonstrations on soil test-based fertilizer application, the yield of maize increased certain extent and the cultivation cost decreased. Because of the balanced application of nutrients, the farmers' net income grew significantly and the soil health improved. Lack of information application of soil test results provided by the Department of Agriculture and other institutions, as well as inaccurate data regarding crop nutrient requirements, are some of the barriers to the widespread use of fertilizer application for maize based on soil tests. Increased maize yield and greater yields are possible if farmers overcome these obstacles by assessing the fertility status of their soil, comprehending the laboratory results, and applying nutrients according to the results of soil tests.

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