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Impact of soil health card based fertilizer recommendations on productivity of maize and profitability of farmers of District Chamba

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ABSTRACT

The present study was carried out to demonstrate the beneficial effects of soil test based fertilizer application. For maintaining proper soil health and attainable crop yield, it is essential to add required amount of fertilizers which is possible by soil testing and also minimizes the misuse of resources. Soil test is an imperative tool for assessing the fertilizer/manure requirements for sustainable crop production and soil fertility. To study the impact of soil test based fertilizer recommendation for maize crop on grain yield and economics, fertilizer recommendations were provided to farmers through front line demonstrations by Krishi Vigyan Kendra, Chamba during 2018 at different locations. Use of soil test data improved soil health, resulting into additional crop yields and quality. Fertilization on soil test basis results in increased maize yield (35 q ha^{-1}) to the tune of 40 % as compared to check (25 q ha^{-1}). It was found that benefit cost ratio was also high in demo (1.33) and low in check (1.2). Thus adoption of soil test based fertilizer application in farmer's field greatly affects different crops to get more crop productivity, economic returns and sustaining soil health. However, there is a need to generate more awareness about the benefits of this technology and right method of fertilizer application. Further, the technological and extension gaps existed in the district which can be bridged by popularizing package of practices and location specific integrated approaches.

1. Introduction

Maize (*Zea mays* L),"Queen of Cereals", is a major kharif crop belonging to graminae family, having wider adaptability under varied agro-climatic conditions. In India, maize is the third most important food crops after wheat and rice. The term corn refers as "to sustain life" that provides nutrients for human and animals worldwide (Elamin and Elagib 2001). Maize is a widely grown crop with a high rate of photosynthetic activity because of its C4 pathway, leading to higher grain yield and biomass potential. It is used in the human diet in both fresh and processed forms such as corn oil, corn flakes, maize starch etc. It has assumed greater significance due to its demand for food, fodder and feed. For livestock, maize provides very nutritious fodder almost throughout the year as fresh/dry fodder or silage. However, maize can be grown on variety of soils, but deep fertile soils rich in organic matter and well-drained soils are the most preferred ones. Since about 85% of maize in India is grown during monsoon season, where over 80% of the total annual precipitation is received, thus proper drainage should be provided to minimize damage due to water logging. The productivity of the crops also depends on nutrient management system. It is a heavy feeder crop and should meet its requirement in order to complete its growing period.

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Inorganic fertilizers are most widely used all over the world as it gives higher yield. Efficient use of nitrogen is important for maize production as it increases the yield and maximizes economic return and minimizes NO_3 leaching to ground (Hokmalipour *et al.,* 2010). In the early stages of maize, deficiency of phosphorous, potassium and zinc inhibit the growth, so it is essential prior to the full development of root system the essential nutrients should be supplied to juvenile maize which may likely promote the growth (Raskar *et al.,* 2013).

In spite of green revolution in India, agriculture production has increased many folds but still there exists a gap between production potential and actual realization. One of the reasons for this wide gap is due to non-adoption of the recommended techniques for the cultivation of crop. Soil fertility management for intensive cropping system is a major component of sustainable agricultural development. For maintaining proper soil fertility, soil health and attainable crop yield, it is essential to add required amount of fertilizers which is possible by soil testing and also minimizes the misuse of resources. Application of soil-test-based fertilizer doses to a crop would help to realize greater response ratio and greater benefit-cost ratio, as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient. In addition, the correction of the nutrient imbalance in soil would help to harness the synergistic effects of balanced fertilization (Rao and Srivastava 2000). However, imbalanced and indiscriminate use of fertilizers has also produced several adverse impacts on soil environment leading to stagnated crop yields in past decades (Kumar *et al.*, 2018). Microbial populations in soil ecosystem are also affected severely due to sole and indiscriminate usage of chemical fertilizers and also lead to environmental pollution (Chitra *et al.*, 2006). So the amount of nutrients to be added to soil for crop production depend on their present amount in that soil.

Hence, soil test based nutrient management play a critical role in ensuring balanced and efficient use of fertilizers and sustaining soil health status and crop productivity. But most of the farmers used to apply chemical fertilizers on the basis of their traditional knowledge without going for soil testing. Keeping in view the constraints, Krishi Vigyan Kendra, Chamba approached the farmers and suggested them to apply fertilizers based on soil testing by conducting front line demonstrations. The front line demonstration (FLD) is an important method of transferring the latest package of practices to the farmers and which would ensure better livelihood, high nutritional security and economic empowerment of marginal farmers. The objective of the study carried out is to demonstrate the impact of soil health card based fertilization on maize yield and economics. Soil health cards provide detailed nutrients information and contains crop-wise nutrient recommendations, corrective measures that helps farmer to obtain good yield potentials and better soil health.

2. Material and methods

The study was conducted in the District Chamba of Himachal Pradesh under rainfed conditions. District Chamba is situated between North latitude 32°11' to 33°13' and East longitude 75°49' to 77°3', at an altitude 645-6776 m amsl and is surrounded on all sides by lofty hill ranges. The mean annual rainfall of the study area is about 1200 mm. The agro climatic zone is Sub humid- Sub temperate & mid hills. Maize is one of the main crops grown by small and marginal farmers for food and fodder in Chamba District. In order to achieve the objective of technology transfer on soil test based fertilizer application and its adoption by the farmers of the region, different extension tools such as training programmes, demonstrations on soil sampling technique, front line demonstrations, etc. were carried out at different locations. The farmers were motivated for soil testing and many farmers follow up the soil testing.

To prove the importance of nutrient management as per soil test results over farmer's practice, eight (8) no. of demonstrations were carried out in four villages of Chamba district viz. Lilly, Chaned, Kiani and Saru. Representative soil samples were collected for analysis of individual demonstration plot to work out nutrient requirement and applied fertilizer on the basis of soil test value. The soil samples were collected to a depth of 0-15 cm before land preparation. The soil samples were air dried in shade for about 24 hour and grinded with the help of pestle and mortar; passes the entire quantity of soil through 2mm stainless sieve. In laboratory these samples were analyzed using Mini Soil Testing Lab (MRIDA PARIKSHAK) developed by ICAR Indian Institute of Soil Science, Bhopal in collaboration with Nagarjuna Agrochemicals (NAC) Pvt. Ltd., Hyderabad (Srivastva *et al.,* 2017). With the help of this Mini Kit soil available nutrients viz. Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S), Boron (B), Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu) and soil reaction (pH), electrical conductivity, organic carbon in a soil sample can be analyzed.

Based on soil test results, the soil health cards were issued to the farmers and recommendations were provided for balanced fertilizer application. On the basis of recommendations, full dose of phosphorus, potassium and half dose of nitrogen applied in field at the time of sowing and remaining dose of nitrogen through urea was applied in two equal split at standing crop. Complete data was collected from farmers about demo and check on yield, cost of cultivation, gross returns, net returns, benefit cost ratio, % increase in yield and finally estimated the technology and extension gaps. To estimate the technology gap, extension gap and technology index following formulae have been used (Matharu and Tanwar 2018).

Technology Gap = Potential yield - Demonstration yield.

Extension Gap = Demonstration yield - Farmer's yield.

Technology Index (%) =

(Technology gap / Potential yield) x 100.

3. Results and Discussions

Chemical properties of Soil

The chemical properties of soils of different location varied from place to place (Table 1). Overall, soils were registered slightly acidic to neutral in reaction and ranged from 6.21 to 7.48 for different locations. The soil electrical conductivity (EC) varied from 0.05 to 0.44 dS m^{-1} with average value of 0.18 dS m^{-1}. The organic carbon content in soils ranged from 0.15 to 2.35%, with average value of 0.89 %. Overall, 25 % soil samples were found deficient, 50 % medium and 25 % high in nitrogen content, 37.5 % soil samples were found deficient, 12.5 % medium and 50 % high in phosphorous content, 25 % soil samples were found deficient, 37.5 % medium and 37.5 % high in potassium content.

Table 1. Soil chemical properties of different demonstration locations.

Location	Soil pH	EC (dS m^{-1})	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
L_1	6.72	0.21	0.49	241	3.56	125.4
L_2	6.62	0.20	0.15	118.7	50.94	322.4
L_3	6.21	0.05	1.59	513.4	104.4	82.55
L_4	6.62	0.04	2.35	702.5	29.47	72.23
L_5	6.21	0.44	0.91	346.6	10.11	276
L_6	6.67	0.08	0.53	252.1	24.13	141.8
L_7	7.15	0.23	0.21	118.7	9.98	313.4
L_8	7.48	0.16	0.96	357.8	66.13	405.0
Mean	6.71	0.18	0.89	331.3	37.3	217.3

Yield parameters

The farmers of district Chamba usually apply urea in their maize fields however some of the farmers also uses 12:32:16 but generally uses over/under doses of fertilizers without soil testing. With the transfer of technology under FLD's on maize, the grain yield of demonstration plots was considerably higher than the farmers' practice (Table 2) which could be due to the adoption of recommended technology in FLD's during the study period. The maize yield of different locations varied from minimum 32.5q ha^{-1} to maximum 37.5q ha^{-1} with average yield 35 q ha^{-1} obtained in demo plot and 25q ha^{-1} obtained in farmers practice (Check). Yields of demo plots were higher because of balanced use of fertilizers based on soil test reports. Thus the FLD might have a positive impact on farming community due to enhanced yield to a tune of 40 % over check. These findings are in the conformity with the results of study carried out by Bhatt (2013), who reported that fertilization on soil test basis results in yield increase of about 1.10-8.12% in sunflower and 10.9-15.0% in gobhi-sarson.

The average potential yield of maize was found to be 40 q ha^{-1}. The technology gap is the difference between the potential yield and demonstration yield and it was 5 q ha^{-1} (Table 2). The technological gap may be attributed due to the dissimilarity in the soil fertility status, erratic rainfall, proper seed rate and spacing, marginal land holdings and other environmental factors (Mishra *et al.,* 2007). Further the extension gap is the difference between demonstration yield and check and it was observed very wide (10q ha^{-1}). This emphasized the need to educate the farmers through various extension means for the adoption of scientific practices in cultivation of crops to bridge the wide extension gap. The technology index shows the feasibility of the improved technology at the farmer's fields. The lower is the value of technology index; the more is the feasibility of technology demonstrated. The technology index was 12.5% which shows the higher feasibility of the demonstrated technology in the district (Table 2).

Table 2. Productivity, technology gap, extension gap and technology index of maize obtained under FLD.

S.N	Variety	Area (ha)	Yield of Demonstration q ha^{-1}		Average Yield q ha^{-1}	Yield under Checkq ha^{-1}	% increase over check	Technology Gap q ha^{-1}	Extension Gap	Technology Index %
			Max	Min						
1.	Kanchan Hybrid-25	0.64	37.5	32.5	35	25	40	5	10	12.5

Economic impact

The farmers under study followed the instructions issued and reduce fertilizer doses to recommended ones. Chouhan *et al.,* (2017) also reported decrease in fertilizer consumption in paddy, soybean and maize after applying fertilizer based on soil test reports among the farmers. So when farmers will apply actual dose of fertilizers based on soil testing report it will not only help to sustain the plant and soil health, but may also reduce the cost involved in procuring the fertilizers thus leads to increase in economic returns. Economic analysis of yield performance revealed that net profit was highest in demo plot compared to check plot and consequently farmers gain additional profit (Table 3). The benefit cost ratio (B:C ratio) was recorded highest in demo plot (1.33:1) over check (1.2:1).These findings are in the conformity with the results of study carried out by Chouhan *et al.,* (2017), who reported that B:C ratio has increased from 1.5 to 1.7 in paddy, from 1.6 to 2.0 in soybean and from 1.4 to 1.9 in maize on adoption of RDF by the farmers. Sharma *et al.*, (2016) also reported that by adopting the technology of balanced use of fertilizers in wheat farmers got more economic return. Hence, the awareness and adoption of recommended scientific package of practices have increased the socio economic status of farming community.

4. Conclusion

From the present study it could be concluded that frontline demonstration was successful in changing the outlook of the farmers towards balanced use of fertilizers on soil test based. Fertilizer recommendations based on soil heath card has been proven as a great step towards sustainable crop production and soil health improvement vis-a-vis reduction in fertilizer dosage by farmers. Higher production under front line demonstration over farmer's practices has created better awareness among the farmers and motivated other farmer's to adopted suitable technology. Technological and extension gaps existed which can be bridged by popularizing package of practices with emphasis on other agronomic practices like use of improved varieties, proper seed rate and spacing, timely irrigation, proper use of plant protection measures, weed management etc. Further, the awareness programmes regarding different method of fertilizer application like drilling, spraying and fertigation in different crops also needed to benefit the farmers. Thus, the farmers can get the higher returns and achieve maximum yields by adopting scientific methods of cultivation compared to farmer's old and unscientific approaches.

Table 3. Economics of front line demonstrations and check.

Year	Economics of demonstration (Rs./ha)				Economics of check (Rs./ha)			
	Gross cost	Gross return	Net return	B:C ratio	Gross cost	Gross return	Net return	B:C ratio
2018	22500	52500	30000	1.33	18750	37500	22500	1.2

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