

Effect of Integrated Nutrient Management on Yield of Maize (*Zea mays* L.)

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Abstract—The basic concept underlying the principles of integrated nutrient management (INM) is the maintenance and improvement of soil fertility for sustaining crop productivity (both quantity and quality wise). The study was carried out during Kharif season of 2013-14 and 2014-15 in two villages across two blocks (Nibaheda and Gangrar) of Chittorgarh district of Rajasthan. In all 30 integrated nutrient management front line demonstrations on maize crop were carried out in an area of 6.0 ha with the active participation of farmers with the objective to demonstrate the latest technology of maize production potential, technological and extension gap, technology index and economic benefit of improved technologies consisting suitable maize varieties Bio 9681 and Prable integrated nutrient management (90:30:30:25 NPK & ZnSO₄ kg ha⁻¹ + Azotobacter + PSB @ 20gkg⁻¹ seed) + seed treatment with *Trichoderma viride* @ 5gkg⁻¹ seed) at Nibaheda and Gangrar blocks of Chittorgarh district during 2013-14 and 2014-15. The results revealed that INM FLD recorded higher yield as compared to farmers' practices over the years of study. The improved technologies recorded average yield of 43.71 q ha⁻¹ which was 24.20 per cent higher than that obtained with farmer's practices of 35.18 q ha⁻¹. In spite of increase in yield of maize, technological gap, extension gap and technology index existed which was 6.29, 8.53 q ha⁻¹ and 12.58 per cent, respectively. The extension gap can be bridged by popularizing package of practices where in stress need to be laid on improved variety, use of proper seed rate, balanced nutrient application and proper plant protection measures. Improved technologies gave higher net return of Rs. 31221 ha⁻¹ with benefit cost ratio 2.47 as compared to local check (Rs. 22886 ha⁻¹, benefit cost ratio 2.19).

Keywords—Maize, INM-FLD, Extension gap, Technological gap, Technology index, Yield, Economics.

I. INTRODUCTION

Maize (*Zea mays* L.) is the most important cereal crop and known as queen of cereal due to unparallel productivity among cereal crops. In India, maize occupies third position

both in area and production after rice and wheat. In Rajasthan it is grown on 1.0 million ha area with production 1.21 m tons and productivity of 1374 kg ha⁻¹. Agriculture is the main stay of life in district Chittorgarh of Rajasthan with a average gross cropped area of 118320 ha. The district has a Sub Humid Southern Plains humid climate with average temperature of the district varies from 30--45°C in summer and 5-25°C in winter. The annual rainfall of the district is about 772 mm. Maize is one of the important cereal crops grown in *kharif* season in the district. Chittorgarh covers 123933 ha of land under maize cultivation with average productivity of 2253 kg ha⁻¹ (Anonymous. 2014) is far below average national productivity (2435 kg ha⁻¹).The potential expected from improved technologies due to erratic rainfall, small land holdings, and adoption of local cultivar, low and imbalance use of fertilizer and no use of plant protection measures. Yield of maize can be enhanced at least 24.20% with adoption of improved technologies such as improved cultivar, recommended dose of fertilizer and control of pests (Dhaka *et al.* 2010), fertilizer and plant protection are most critical inputs for increasing yield (Mishra *et al.* 2009). Realizing the situation INM front line demonstrations on maize production technology were planned and conducted to show the production potential, economic benefit of improved technologies under real farmers' conditions.

II. MATERIALS AND METHODS

In the present study performance of improved technologies of maize against local check was evaluated through INM front line demonstrations conducted at farmer's field during *Kharif* season of 2013-14 and 2014-15. A total of 30 demonstrations were laid on 6.0 hectare area in 02 villages across two blocks (Nibaheda and Gangrar) of Chittorgarh district of Rajasthan. In the year 2013, front line demonstrations conducted in 03 ha area on maize with variety Bio-9681 and the year 2014 variety of Prable (Maize) has sown. The each demonstration of improved technologies of maize was demonstrated in an area of 0.2

to 0.4 ha adjacent to the plots of farmer's practices (Local check). Soils of the study area are mostly sandy clay loam in texture with low nitrogen, medium phosphorus and available potassium. The improved technologies included improved varieties (cv. Bio-9681 during 2013 and cv. 'Prable' during 2014), integrated nutrient management (90:30:30:25 NPK & ZnSO₄ kg ha⁻¹ + PSB @ 20 gkg⁻¹ seed) + seed treatment with *Trichoderma viridae* @ 6 gkg⁻¹ seed) were tested under demonstrations. Deep ploughing was done during the month of April. Crop was sown after receiving sufficient rainfall, between last week of June to 2nd week of July with crop geometry of 60 × 20 cm and seed sown at 25 kg ha⁻¹. Total amount of phosphorus, potassium and zinc sulphate applied through DAP, MOP and ZnSO₄ as basal dose and nitrogen through urea as top dressed in two equal splits at 30 and 45 days after sowing. The seeds were treated with *Trichoderma viridae* @ 6 gkg⁻¹ seed and then seeds were inoculated by *Azotobacter* and phosphor-solubilizing bacteria biofertilizers each 20 gkg⁻¹ seeds. Hand weeding was done once at 25 days after sowing. The crop was harvested between second weeks of October. At harvesting, five random samples of one meter square area from each demonstration fields were harvested and composite sample was weighted for total biological yield. After weighing, seeds were separated by beating and cleaned grains were weighted for grain yield. The technology gap, extension gap and technology index were calculated as suggested by Samui *et al.* (2000).

$$\text{Technology Gap} = \text{Potential yield} - \text{Demonstration yield}$$

$$\text{Extension Gap} = \text{Demonstration yield} - \text{Farmers yield}$$

$$\text{Technology Index (\%)} = \frac{\text{Potential yield} - \text{demonstration yield}}{\text{Potential yield}} \times 100$$

III. RESULTS AND DISCUSSION

Perusal of data indicated that the average yield of maize was substantially higher as compared to local check over the years of study (Table 1). The productivity of maize ranged from 41.78 to 45.64 qha⁻¹ with mean yield 43.71 qha⁻¹ under improved technologies at farmers fields as against a yield ranged from 33.97 to 36.39 qha⁻¹ with an average of 35.18 qha⁻¹ under farmer's practices (local check). The highest productivity following improved technology was during the year 2014 which is might be due to improved cultivar Prable and rainfall received on the critical stages of crop growth. Increase in yield was 22.99 and 25.42 percent higher as compared to local check, during 2013 and 2014, respectively. The higher yield of maize under improved technologies was due to the latest high yielding varieties, integrated nutrient management and integrated pest management. Similar results have been reported earlier by Segar and Chandra (2004), Jeengar *et al.* (2006) and Dhaka *et al.* (2010).

Table.1: Productivity, technology gap, extension gap and technology index of maize under INM FLDs

Year	Area (ha)	No. of farmers	Potential	Yield (qha ⁻¹)		Per cent increase In yield over local check	Technology Extension gap (qha ⁻¹)	Technology gap (qha ⁻¹)	Technology Index (%)
				Improved	Local				
2013	3.0	15	50.0	41.78	33.97	22.99	8.22	7.81	16.44
2014	3.0	15	50.0	45.64	36.39	25.42	4.36	9.25	8.72
Mean	3.0	15	50.0	43.71	35.18	24.20	6.29	8.53	12.58

Table.2: Cost of cultivation (Rsha⁻¹), net return (Rsha⁻¹) and B: C ratio as affected by improved technology and local practices

Year	Cost of cultivation		Net Returns		B:C Ratio	
	Improved	Lock check	Improved	Lock check	Improved	Lock check
2013	20210	18210	29926	22254	2.48	2.22
2014	22252	20150	32516	23518	2.46	2.16
Mean	21231	19180	31221	22886	2.47	2.19

The technological gap, which is the difference between potential and demonstration yield was maximum in the year 2013 (8.22 qha⁻¹) and lowest in the year 2014 (4.36 qha⁻¹). However, overall average technological gap in the study was 6.29 qha⁻¹. The technological gap observed may be attributed to the dissimilarity in soil fertility status and

weather conditions. Mukharjee (2003) has also opined that depending on identification and use of farming situation, specific interventions may have greater implications in enhancing system productivity. The extension gap ranged from 7.81 to 9.25 qha⁻¹ during the period of study emphasizes the need to educate the farmers through various

means for adoption of improved technologies to reverse the trend of wide extension gap. Technology index shows the feasibility of evolved technology at the farmer's field and lower the value of technology index more is the feasibility of the technology (Jeengar *et al.* 2006). Technology index in the present case varied between 8.72 to 16.44 per cent and averaged 12.58 per cent during the period of study.

The inputs and outputs prices of commodities prevailed during each year of demonstrations were taken for calculating cost of cultivation, net return and benefit cost ratio (Table 2). The investment on production by adopting improved technologies ranged from Rs. 29926 to 32516 ha⁻¹ with a mean value of Rs. 31221 ha⁻¹ against local check where the variation in cost of production ranged from Rs. 20210 to 22252 ha⁻¹ with an average of Rs. 21231 ha⁻¹. The cultivation of maize under improved technologies gave higher net return of Rs. 29926 and 32516 ha⁻¹ as compared to Rs. 22254 and 23518 ha⁻¹ under local check in the corresponding years. The average benefit cost ratio of improved technologies was 2.47, varying from 2.46 to 2.48 and that of local check was 2.19, varying from 2.16 to 2.22. This may be due to higher yields obtained under improved technologies compared to local check (farmers practice). This finding is in corroboration with the finding of Mokidue *et al.* (2011), Tomar (2010) and Solanki *et al.* (2014).

Reasons of low yield of maize at farmer's fields

Optimum sowing time is not followed due delay in monsoon. Sometimes non availability of quality seed or variety seed and farmers go for the local seed in hand. More than 80 per cent of farmers maize seed sowing in closer spacing and in most of the situation the plant population at farmer's field is high or two-three times high of the recommended stand. Lack of popularization of seed cum fertilizer drill for sowing and use of inadequate and imbalance dose of fertilizers especially the phosphatic, potassic fertilizers by farmers does not make possible to fetch potential yield. The problem of nutrient deficiency in maize plant substantial loss in the maize crop yield measures. Mechanical weed control is costly and chemical control is quite uncommon in this region.

Specific constraints with marginal/sub marginal farmer's

Small holding: The adoption of well proven technology is constrained due to small size of holding and poor farm resources. Small and marginal farmers have less capability to take risk and do not dare to invest in the costly inputs due to high risk and the poor purchase capacity of small farmer.

Farm implements and tools: Traditional implements and tools are still in practice due to small holdings which have poor working efficiency. The lack of simple modern tools for small holdings also hinders the adoption of improved technologies.

IV. CONCLUSION

Thus, the cultivation of maize with improved technologies including suitable variety with integrated nutrient has been found more productive and grain yield might be increase up to 25.42%. Technological and extension gaps existed which can be bridged by popularizing package of practices with emphasis on improved variety seed, use of proper seed rate, balanced nutrient application-integrated nutrient management. Replacement of local variety with the released variety of maize would increase the production and net income by more than nine thousand rupees.

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