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Growth, Yield and Economics of Maize (*Zea mays* L.) Varieties under Front Line Demonstrations in Ganderbal, Jammu and Kashmir

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A B S T R A C T

The front line demonstrations (FLDs) on two maize varieties were carried out in district Ganderbal during maize growing season of 2017, 2018 and 2019. In total 44 FLDs were carried out on an area of 13.5 ha. The varieties demonstrated as per the region adaptability were SMC (Shalimar maize composite)-4 and SMC-7 and compared with the local check. The plant height, plant girth, leaf area index, green fodder yield (32.7 t/ha), dry fodder yield (7.2 t/ha) and grain yield (5.1 t/ha) were higher in SMC-7 as compared to SMC-4 and Check. SMC-4 also performed better than the check variety. The grain yield of SMC-7 and SMC-4 was 69 and 45% higher than the check yield. Net returns (Rs. 111,000 in SMC-7 and 80,153 in SMC-4) in the demonstrated varieties were higher than the check. The benefit cost ratio in SMC-7 and SMC-4 was 35 and 18% higher than the check variety. Significant positive correlation of grain yield was observed with plant height (r=0.98), green (r=0.95) and dry fodder yield (r=0.95).

Introduction

Maize (*Zea mays* L.) is one of the most important cereal, next to wheat and rice in the world as well as in India. Maize is a miracle crop called as "Queen of Cereals" and is grown with equal success in temperate, subtropical and tropical regions of the world in more than 130 countries. It is of great importance for both human and animal feeding. Asia contributes about one-third to the world's total maize production with China taking the lead both in terms of yield and area. In Asia, maize demand is expected to rise from 138 million tonnes in 1993 to 243 million tonnes, accounting for 60 per cent of the global increase in maize consumption by 2020 (Baba and Mir, 2018). The area under maize cultivation in Jammu and Kashmir during 2016-17 was 295.2 thousand hectare with a production of 5411 thousand quintals and an average production of 18.3 q/ha (J&K Envis Newsletter, 2017). During 2018-2019, Maize was grown on an area of 6450 ha in district Ganderbal, with production and productivity of 12463 quintal and 28.4 q/ha (Table 1). During the period of 2011-12 to 2018-19, the area under district has increased

by 29%. The production and productivity during this period has increased by 185 and 120%, respectively (Table 1). This has been mainly due to the technological interventions of Krishi Vigyan Kendra, Ganderbal and the district agriculture department.

The rapid adoption of high-yielding/improved maize varieties has led to significant yield increases in the favourable rain-fed and irrigated maize growing areas. In recent years, the majority of farmers in favourable maize growing areas have switched to improved/hybrid varieties for its superior yield and profit, resistance to several biotic and abiotic stresses (Dar *et al.,* 2017; Dar *et al.,* 2014) despite the higher seed cost.

Jammu & Kashmir, one of the Himalayan states of India, is the traditional maize growing region in the country. Augmentation of maize productivity is imperative for uplifting smallholder farmers in the state. Research & Development institutions have developed a number of varieties and input technologies for the development of maize sector of the state. Besides, the state government also promotes composite seeds through State Seed Corporation and the promising varieties are generally procured from the private sector.

However, the adoption of improved maize varieties by the farmers is still poor. Intensification in yield by using technical interventions in FLDs plots was reported by Patil *et al.,* (2019) and Teggelli *et al.,* (2018). Higher net returns and benefit cost ratio in demonstration plots as compared to farmer practices was reported by Meena *et al.,* (2018) and Yadav *et al.,* (2020).

Thus in this backdrop, the front line demonstrations were carried out by Krishi Vigyan Kendra Ganderbal to demonstrate the performance of improved maize varieties in the district and to improve the adaptability of high yielding varieties developed by the university.

Materials and Methods

The front line demonstrations were carried out by Krishi Vigyan Kendra Ganderbal in different villages of the district during the maize growing season of 2017, 2018 and 2019. In total 44 FLDs were carried out on an area of 13.5 ha. The varieties demonstrated as per the region adaptability were SMC-4 and SMC-7 and compared with the local check. For carrying out the front line demonstrations, farmers were selected on the basis of interest towards adoption of improved varieties, site of field and technical know-how of farmer. All the necessary inputs were provided to selected farmers and regular visits of scientist to the demonstrated field was carried out. Trainings, grouping meetings and field day were organized from time to time for awareness of technologies among the farmers and to provide remedy to the problems faced by them. The sowing was done in first fortnight of May during all the years. All the improved cultivation practices like fertilizer, herbicide, irrigation and plant protection measures were demonstrated to the farmers as per the recommended guidelines (SKUAST-K package of practices). The yield data was recorded from demonstrated plots as well as farmers' practices plots. Plant height, plant girth, leaf area index, yield, cost of cultivation, gross return, net return and benefit cost ratio were computed and analyzed as per the standard procedures (Dar *et al.,* 2014). T-test was done to compare the demonstrated varieties with the check using Proc GLM procedure and correlation analysis was done to find the correlation of grain yield with growth and yield attributes using Proc CORR procedure of SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA).

Results and Discussion

Plant height, Plant girth and leaf area index

The results of Front line demonstrations conducted during the three years in different villages of district Ganderbal using high yielding varieties and improved crop management practices revealed that SMC-7 recorded the plant height, plant growth and leaf area index (LAI) as compared to SMC-4 and check variety (Table 2). The mean plant height (207 cm), plant girth (7.4 cm) and LAI of demonstration plots (6.8) were significantly higher than the check (163 cm, 6.6 cm and 5.8, respectively). On percentage basis, the mean plant height, girth and leaf area index in demonstration plots was 27, 12 and 17% higher than the check variety. An increase in growth attributes by technological interventions was also reported by Dar *et al* (2018a), Dar *et al.,* (2017a), Dar *et al.,* (2019b) and Yadav *et al.,* (2020).

Table.1 Status of Maize crop in district Ganderbal

Crop	2011-12			2018-19		
	Area (ha)	Production (q)	Productivity (q/ha)	Area (ha)	Production (q)	Productivity (q/ha)
Maize	5003	4373	12.9	6450	12463	28.4

Table.2 Effect of varieties on growth attributes of maize, green fodder yield, dry fodder yield and grain yield at harvest under front line demonstration in district Ganderbal (Average of 2017, 2018 and 2019)

Treatment	No. of Demo.	Area (ha)	Plant height (cm)		Plant girth (cm)		Leaf area index		Green fodder yield (t/ha)		Dry fodder yield (t/ha)		Grain yield (t/ha)	
Variety			Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check
SMC-4	29	8.5	203	160	7.3	6.5	6.7	5.5	30.5	20.5	6.6	5.0	4.1	2.8
SMC-7	15	5.0	210	165	7.5	6.7	6.9	6.0	32.7	20.9	7.2	4.4	5.1	3.0
Mean			207	163	7.4	6.6	6.8	5.8	31.6	20.7	6.9	4.7	4.6	2.9
Demo vs Check (Pr > [t])			0.0081**		0.0442*		0.0142**		0.0006**		0.0007**		0.0012**	

Table.3 Economics of maize varieties under front line demonstration in district Ganderbal (Average of 2017, 2018 and 2019)

Variety	Economics of demonstration (Rs./ha)				Economics of check (Rs./ha)			
	Gross Cost	Gross Return	Net Return	BCR	Gross Cost	Gross Return	Net Return	BCR
SMC-4	46800	126953	80153	2.71	44500	102300	57800	2.29
SMC-7	47300	158300	111000	3.35	44000	109850	65850	2.49

Table.4 Correlation of grain yield with other growth and yield attributes

	Pearson Correlation Coefficients: Prob > |r| under H0: Rho=0				
	Plant height	Plant girth	Leaf area index	Green fodder yield	Dry fodder yield
Grain Yield	0.98**	0.83*	0.77*	0.95**	0.95**

Green fodder yield and dry fodder yield

The green fodder yield and dry fodder yield was higher in SMC-7 as compared to SMC-4 and check variety. The mean green fodder yield of demonstration plots (31.6 t/ha) was significantly higher than the check varieties (20.7 t/ha) by 53%, while as the dry fodder yield was significantly higher by 47%. The increase in fodder yield may be attributed to better growth attributes of the demonstrated varieties (Table 2). An increase in yield attributes by technological interventions was also reported by Dar *et al.,* (2018b), Kumari *et al.,* (2014) and Yadav *et al.,* (2020).

Grain yield

The results of Front line demonstrations conducted during 2017- 2019 in different villages of district Ganderbal using high yielding varieties and improved crop management practices revealed that SMC-7 recorded the highest grain yield of 5.1 t/ha as compared to the yield of 3.0 t/ha by the check variety (Table 2). The yield was 68% higher than the check variety. SMC-4 also resulted in higher yield (4.1 t/ha) than the check varieties (2.8 t/ha). The mean grain yield of 4.6 t/ha was significantly higher than the check variety (2.9 t/ha) by 59%. An increase in yield by technological interventions in FLDs may be attributed to the provision of better environment and availability of inputs to the crop in right amount and at right time together with adoption of high yielding varieties. An increase in yield by technological interventions was also reported by Singh and Bisen (2020), Dar *et al.,* (2017b), Dar *et al.,* (2019a), Kumari *et al.,* (2014) and the farmers are thus advised to cultivate SMC-7 variety as compared to the local landraces.

Economics

The economics of different maize varieties under front line demonstrations revealed that SMC-7 is best with a net income of Rs. 111,000/ha and a benefit cost ratio of 3.35 as compared to the net returns of Rs. 65,850/ha in check plot, which was 41% lower than SMC-7. The net returns in SMC-4 were Rs. 80,153 which was 39% higher yield than the check (Table 3). The higher net returns and benefit cost ratio may be attributed to higher yield in the demonstration plots as compared to the check. Similarly increase in income with adoption of improved cultivation practices was also reported by Yadav *et al.,* (2020) and Singh and Bisen (2020).

Correlation analysis

The correlation analysis of plant height, plant girth, LAI, green and dry fodder yield with grain yield (Table 4) revealed that all these attributes have significant positive effect on grain yield. This means that more the plant height, girth, LAI, green and dry fodder yield, higher will be the grain yield. The maximum correlation for grain yield was found with plant height (r=0.98) followed by green fodder yield (r=0.95), dry fodder yield (r=0.95) plant girth (r=0.83) and LAI (r=0.77).

From the study it can be concluded that adoption of high yielding varieties like SM-7

together with recommended cultivation practices resulted in an increase in the yield and monetary income of farmer and thus need to be adopted by the farmers.

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