



## Evaluation of varieties of different types of maize under organic farming

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### ABSTRACT

Varietal evaluation of maize under organic input management provides protection against reduction in yield due to lack of suitable technology for growing potential varieties with organic inputs especially for plant nutrition supply. In this study 12 varieties of different types of maize comprising Hybrids, Sweet corn, Baby corn, Popcorn and Local were grown in southern west tribal part of Rajasthan, India for evaluation under organic system of plant nutrient management during *kharif* 2015–16. Sweet corn variety, Misty recorded significantly higher plant height at flowering during *kharif* 2015–16 (121.44 cm and 117.67 cm, respectively), maize hybrid variety T<sub>3</sub> (PHM-3) recorded significantly higher dry matter accumulation at tasseling stage (83.33 g/plant & 81.00 g/plant, respectively) and sweet corn variety T<sub>4</sub> (Sugar-75) recorded significantly higher leaf area index at silking stage (4.23 and 4.23, respectively) as compared to other varieties of different types of maize grown under organic system of plant nutrient management. During 2015 and 2016, variety T<sub>9</sub> (VL-Amber of popcorn) recorded maximum maize equivalent yield (165.57 q/ha and 117.03 q/ha, respectively) and net return (₹ 218120/ha and ₹ 139741/ha, respectively).

**Keywords:** Maize, Net return, Organic farming, Varieties, Yield

The extensive and indiscriminate use of chemical fertilizers and other agro-chemicals in intensive farming have deteriorated soil health, soil macro and microflora, quality of water, food and fodder (Sharma *et al.* 2017). These synthetic chemicals have not only reduced quality of farm produces but have adversely affected the human and animal health due to their entry in food chain (Biswas and Sharma 2008). Thus, organic farming has shown its effectiveness in sustaining soil and environmental quality/health and maintaining ecosystem services. Due to ever increasing health issues posed by agrochemicals in intensive agriculture, the organic products have gained popularity among the consumers and at present organic farming is being practiced in 181 countries across the world (Willer and Julia 2019). Acreage under organic agriculture in India is 5.71 while total production of certified organic products is 1.35 million metric tons (APEDA 2017-18). Maize is the most dominant crop of Rajasthan in North West India. Due to the increasing demand and consumer preferences, maize is now becoming the most popular crop in developing nations like India (Kumar *et al.* 2019). Rajasthan is a leading

maize growing state in India and stands 1<sup>st</sup> in terms of maize cultivated area. Similarly, southern districts of Rajasthan have the largest growing area than any districts in India. Several research studies across the globe have indicated variations in crop and cultivar performance from one site to other (Barbari 2002). Response of varieties to organic inputs is not similar among all maize cultivar. So, there is a need to identify suitable varieties for growing under organic input supply including nutrient, pest and disease management.

Hence in view of above consideration, this study was planned to identify the potential varieties of different types of maize suitable for high yield and better net return under organic system of plant nutrient management in tribal part of south western Rajasthan, India.

### MATERIALS AND METHODS

*Experimental site description:* The present study on evaluation of varied genotypes of maize grown under organic nutrient management through organics in south western tribal part of Rajasthan, India was piloted during *kharif* 2015 and 2016 at organic farming unit, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan. Udaipur is located at 24.55° N latitude, 73.71° E longitude and altitude 582.17 m in the heart land of Aravalli Hills. The furrow slice (0-15 cm) soil of experimental site were clay loam with pH 8.1 (1:2 soil: water), medium organic carbon (0.55%), low in

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available N (220 kg/ha), high in available P (34.20 kg/ha), high in available K (235.5 kg/ha), 3.05 ppm available iron and 0.45 ppm available zinc. The weekly meteorological observations for the experimental station showed that during the crop season of 2015 and 2016, precipitation was 523.8 and 721.7 mm. The maximum and minimum temperatures were 42°C and 14.6°C (*Kharif*2015) and 37.6°C and 18.5°C (*Kharif* 2016), respectively.

*Experimental design and treatments:* Research study comprised 12 treatments on different types of maize (Hybrids, Sweet corn, Baby corn, Popcorn and Local) grown under organic system of plant nutrient management as per National Programme on Organic Production principles approved by Government of India (APEDA 2017-18). The treatments were laid out in a randomized block design (RBD) with three replications. All recommended management practices for agronomic, nutrient, pest and disease were followed as per the standards of organic farming.

*Leaf area index:* The leaf area index (LAI) was worked out by using standard formula as described by Watson (1947).

*Maize equivalent yield:* Maize equivalent yield (MEY) was calculated as per current market prices of both maize and other different types of maize (Panda 2014).

*Economic analysis:* The gross return was calculated using current market selling price of grain and stover. The net return was calculated on the basis of differences between gross return and total cost of cultivation. Benefit-cost ratio was calculated to find out most profitable treatments.

*Statistical analysis:* The experimental data obtained from various treatments were statistically analyzed by using Analysis of variance method (ANOVA) procedure (Gomez

and Gomez 1984) for the RBD using R Studio software. The least significant difference test was used to interpret the treatment effect at the 5% level of significance ( $P < 0.05$ ). The analysis for economics was statistically calculated and highest B:C ratio was considered most profitable.

## RESULTS AND DISCUSSION

*Plant height at flowering stage:* Being different types of maize, it was evident to get variable plant height of different types of maize at flowering stage (Table 1). Among the different maize varieties, T<sub>6</sub> (sweet corn variety Misty) proved significantly superior in plant height during 2015 and 2016 (121.4 cm and 117.6 cm, respectively) compared with other varieties but found at par with T<sub>7</sub> (Baby corn variety PM-3) in the year 2016. Among the grain maize varieties, T<sub>1</sub> (PQPM-1) showed significantly maximum plant height (90.33 cm) was recorded in variety T<sub>1</sub> (PQPM-1) during 2015 as compared to T<sub>3</sub> (variety PHM-3) (68.44 cm) and it was found at par with T<sub>2</sub> (PM-9) variety (89.44 cm). However, during 2016, all the grain maize varieties were found statistically at par with each other in terms of plant height. Concurrently, in case of sweet corn varieties, variety T<sub>6</sub> (Misty) proved significantly superior in plant height during 2015 and 2016 (121.44 cm and 117.67 cm, respectively) over the other sweet corn varieties. T<sub>7</sub> (PM-3) recorded significantly higher plant height (91.11 cm and 118.33 cm, respectively) as compared to T<sub>8</sub> (PM-5) (61.56 cm and 95.00 cm, respectively) during both the years in case of baby corn varieties. Likewise, during 2015 and 2016, T<sub>10</sub> (Amber popcorn) resulted significant higher plant height (92.11 cm and 88.33 cm) as compared to variety T<sub>9</sub> (VL-Amber popcorn) (78.22 cm and 71.67 cm, respectively).

Table 1 Growth parameters of different varieties of maize grown under organic management

Variety		Plant height at flowering stage (cm)		Dry matter accumulation at tasseling (g/plant)		Leaf area index at silking stage	
		2015	2016	2015	2016	2015	2016
Grain maize	T <sub>1</sub>	90.33 <sup>bcd</sup>	86.67 <sup>b</sup>	72.83 <sup>b</sup>	75.00 <sup>b</sup>	3.20 <sup>e</sup>	3.22 <sup>f</sup>
	T <sub>2</sub>	89.44 <sup>bcd</sup>	94.00 <sup>b</sup>	46.00 <sup>de</sup>	46.67 <sup>cd</sup>	3.39 <sup>d</sup>	3.42 <sup>ef</sup>
	T <sub>3</sub>	68.44 <sup>cde</sup>	92.33 <sup>b</sup>	83.33 <sup>a</sup>	81.00 <sup>a</sup>	4.18 <sup>a</sup>	4.20 <sup>a</sup>
Sweet corn	T <sub>4</sub>	67.11 <sup>de</sup>	66.00 <sup>c</sup>	40.67 <sup>f</sup>	50.00 <sup>c</sup>	4.23 <sup>a</sup>	4.23 <sup>a</sup>
	T <sub>5</sub>	100.11 <sup>ab</sup>	69.67 <sup>c</sup>	33.50 <sup>g</sup>	32.33 <sup>e</sup>	3.58 <sup>c</sup>	3.60 <sup>cde</sup>
	T <sub>6</sub>	121.44 <sup>a</sup>	117.67 <sup>a</sup>	46.00 <sup>de</sup>	48.00 <sup>cd</sup>	3.60 <sup>c</sup>	3.57 <sup>de</sup>
Baby corn	T <sub>7</sub>	91.11 <sup>bcd</sup>	118.33 <sup>a</sup>	47.67 <sup>c</sup>	46.67 <sup>cd</sup>	3.81 <sup>b</sup>	3.82 <sup>bc</sup>
	T <sub>8</sub>	61.56 <sup>e</sup>	95.00 <sup>b</sup>	50.00 <sup>c</sup>	51.00 <sup>c</sup>	3.62 <sup>c</sup>	3.65 <sup>cde</sup>
Popcorn	T <sub>9</sub>	78.22 <sup>bcde</sup>	71.67 <sup>c</sup>	26.23 <sup>h</sup>	26.33 <sup>f</sup>	3.86 <sup>b</sup>	4.04 <sup>ab</sup>
	T <sub>10</sub>	92.11 <sup>bc</sup>	88.33 <sup>b</sup>	23.83 <sup>h</sup>	22.67 <sup>f</sup>	3.21 <sup>e</sup>	3.24 <sup>f</sup>
Local	T <sub>11</sub>	93.78 <sup>b</sup>	93.33 <sup>b</sup>	48.07 <sup>d</sup>	49.33 <sup>cd</sup>	3.63 <sup>c</sup>	3.66 <sup>cd</sup>
	T <sub>12</sub>	91.00 <sup>bcd</sup>	87.67 <sup>b</sup>	42.80 <sup>ef</sup>	44.00 <sup>d</sup>	4.18 <sup>a</sup>	4.20 <sup>a</sup>
	LSD 0.05 <sup>a</sup>	24.40	13.734	3.748	5.291	0.118	0.229

T<sub>1</sub> - PQPM - 1, T<sub>2</sub> - PM - 9, T<sub>3</sub> - PHM - 3, T<sub>4</sub> - Sugar 75, T<sub>5</sub> - Madhula, T<sub>6</sub> - Misty, T<sub>7</sub> - PM- 3, T<sub>8</sub> - PM- 5, T<sub>9</sub> - VL Amber popcorn, T<sub>10</sub> - Amber popcorn, T<sub>11</sub> - Navjot and T<sub>12</sub> - Farmers Selection. Different lower-case letters within columns indicate that treatment means significantly differ according to LSD test ( $P=0.05$ ). <sup>a</sup> Column values followed by the similar letter(s) are not significantly different ( $P < 0.05$ ) according to least significant difference test.

While, among the local varieties, during 2015, variety T<sub>11</sub> (Navjot) recorded significantly higher plant height (93.78 cm) as compared to variety T<sub>12</sub> (Farmers Selection) (91.00 cm). However, during 2016, no significant differences were found in the plant height among local varieties. Plant height is important growth parameter in determining yield contributing characteristics and finally affects the grain & straw yield (Reddy and Reddy 1997). Significant increase in plant height at flowering stage among different varieties can be attributed to variations in their genetic makeup. These results are in accordance with (Das *et al.* 2012) who observed different plant height in the different rice varieties under organic farming.

*Dry matter accumulation at tasseling stage:* Significantly highest (83.33 g/plant and 81.00 g/plant, respectively) dry matter accumulation at tasseling stage was observed in variety T<sub>3</sub> (PHM-3) among all the varieties used during both the years of experimentation (Table 1). Among the grain maize varieties, variety T<sub>3</sub> (PHM-3) recorded significantly higher dry matter accumulation during 2015 and 2016 (83.33 g/plant and 81.00 g/plant, respectively) in comparison to other grain maize varieties. During 2015 variety T<sub>6</sub> (Misty) obtained significantly maximum dry matter accumulation (46.00 g/plant) as compared to other sweet corn varieties, whereas in 2016, significantly higher dry matter accumulation (50.00 g/plant) was found in variety T<sub>4</sub> (Sugar-75) as compared to other sweet corn varieties. Contrary to grain maize and sweet corn varieties no significant difference in dry matter accumulation was recorded under all the baby corn and popcorn varieties during both the years. Data further revealed that variety T<sub>11</sub> (Navjot) gave significantly higher dry matter accumulation during 2015 and 2016 (48.07 g/plant and 49.33 g/plant, respectively)

in comparison to variety T<sub>12</sub> (Farmers Selection) (42.80 g/plant and 44.00 g/plant, respectively) among the local varieties used for the experiment.

The dry matter accumulation was recorded significantly higher at tasseling stage might be due to better photosynthesis as evident from higher LAI, duration of variety and favorable response to organic farming conditions. Significantly higher leaf area index at silking stage might be attributed to increase in chlorophyll content in maize leaves influenced by better nutrition under organic production system and varietal characters (Kumar *et al.* 2016, Sharma *et al.* 2021 and Layek *et al.* 2017). Differential response of varieties of wheat under organic farming was noticed earlier by Yadav *et al.* (2020).

*Leaf area index at silking stage:* The data pertaining to leaf area index (LAI) of maize at silking stage (Table 1) revealed that among the different maize varieties, variety T<sub>4</sub> (Sugar-75) recorded significantly higher LAI during 2015 and 2016 (4.23 and 4.23, respectively) among all the maize varieties used, however, it was found at par with variety T<sub>3</sub> (PHM-3) (4.18 and 4.20, respectively) and variety T<sub>12</sub> (Farmer Selection) (4.18 and 4.20, respectively). Variety T<sub>3</sub> (PHM-3) recorded significantly higher LAI (4.18 & 4.20, respectively) among all the grain maize varieties. Similarly, among sweet corn varieties, variety T<sub>4</sub> (Sugar-75) recorded significantly higher LAI (4.23 and 4.23, respectively) as compared to variety T<sub>5</sub> (Madhula) and variety T<sub>6</sub> (Misty) during 2015 and 2016, respectively. However, the LAI of variety T<sub>6</sub> (Misty) and variety T<sub>5</sub> (Madhula) was found at par during 2015. Among baby corn varieties, variety T<sub>7</sub> (PM-3) recorded higher leaf area index (3.81 and 3.82, respectively) as compared to variety T<sub>8</sub> (PM-5) during 2015 and 2016. While, among popcorn varieties, variety T<sub>9</sub>

Table 2 Maize equivalent yield and economics of different varieties of maize grown under organic management

Variety	Maize equivalent yield (q/ha)		Net return (₹ /ha)		B C ratio		
	2015	2016	2015	2016	2015	2016	
Grain maize	T <sub>1</sub>	55.81 <sup>cd</sup>	58.33 <sup>bc</sup>	60541	70686	2.08	2.27
	T <sub>2</sub>	45.07 <sup>de</sup>	44.62 <sup>de</sup>	39972	45745	1.72	1.82
	T <sub>3</sub>	70.21 <sup>bc</sup>	62.96 <sup>bc</sup>	88171	84465	2.58	2.51
Sweet corn	T <sub>4</sub>	90.55 <sup>b</sup>	63.48 <sup>bc</sup>	96610	47335	2.23	1.60
	T <sub>5</sub>	38.91 <sup>de</sup>	56.21 <sup>bcd</sup>	3911	29970	1.05	1.38
	T <sub>6</sub>	54.67 <sup>cd</sup>	59.72 <sup>bc</sup>	32090	36935	1.41	1.47
Baby corn	T <sub>7</sub>	37.56 <sup>de</sup>	51.83 <sup>cd</sup>	21258	35706	1.38	1.64
	T <sub>8</sub>	31.94 <sup>e</sup>	38.87 <sup>e</sup>	10345	14981	1.19	1.27
Popcorn	T <sub>9</sub>	165.57 <sup>a</sup>	117.03 <sup>a</sup>	218120	139741	4.96	3.54
	T <sub>10</sub>	48.11 <sup>de</sup>	65.33 <sup>b</sup>	29000	60110	1.53	2.09
Local	T <sub>11</sub>	39.46 <sup>de</sup>	35.18 <sup>e</sup>	26047	31450	1.47	1.57
	T <sub>12</sub>	52.26 <sup>cde</sup>	54.25 <sup>bcd</sup>	54716	65500	1.99	2.18
	LSD 0.05 <sup>a</sup>	21.533	11.273				

T<sub>1</sub> - PQPM - 1, T<sub>2</sub> - PM - 9, T<sub>3</sub> - PHM - 3, T<sub>4</sub> - Sugar 75, T<sub>5</sub> - Madhula, T<sub>6</sub> - Misty, T<sub>7</sub> - PM- 3, T<sub>8</sub> - PM- 5, T<sub>9</sub> - VL Amber popcorn, T<sub>10</sub> - Amber popcorn, T<sub>11</sub> - Navjot and T<sub>12</sub> - Farmers Selection. Selling price (₹ /kg): Grain: 15, Stover: 5.1

(VL-Amber Popcorn) recorded significantly higher leaf area index during 2015 and 2016 (3.86 and 4.04, respectively) as compared to variety T<sub>10</sub> (Amber popcorn). Further, local varieties resulted that variety T<sub>12</sub> (Farmer Selection) gave significantly higher leaf area index (4.18 and 4.20, respectively) as compared to variety T<sub>11</sub> (Navjot). The higher total dry matter production was directly related to LAI. Accumulation of dry matter during the crop growth and its partitioning has a correlation with leaf area and other growth parameters (Bharadwaj and Kalindi 1986). Since the duration of sweet corn variety Sugar-75 is less than variety PHM-3, so total dry matter production is more in case of variety PHM-3 instead of higher LAI in variety Sugar-75. This was in appendage with the findings of Kudachikar and Janagoudar (1999).

**Maize equivalent yield:** The data on maize equivalent yield (Table 2) showed that among the maize varieties, variety T<sub>9</sub> (VL-Amber popcorn) recorded significantly higher maize equivalent yield during 2015 and 2016 (165.57 q/ha and 117.03 q/ha, respectively) as compared to other varieties. Among grain maize varieties, variety T<sub>3</sub> (PHM-3) recorded significantly higher maize equivalent yield (70.21 q/ha and 62.96 q/ha, respectively) in comparison to variety T<sub>2</sub> (PM-9) and it was found at par with variety T<sub>1</sub> (PQPM-1). Where in the group of sweet corn varieties during 2015, variety T<sub>4</sub> (Sugar-75) recorded significantly higher maize equivalent yield (90.55 q/ha) in comparison to variety T<sub>6</sub> (Misty) and variety T<sub>5</sub> (Madhula). However, during 2016, no significant difference in maize equivalent yield was recorded among all the sweet corn varieties. Similar trends were recorded by baby corn varieties during 2015 while, during 2016 variety T<sub>7</sub> (PM-3) recorded significantly higher maize equivalent yield (51.83 q/ha) over the other baby corn varieties. Popcorn variety T<sub>9</sub> (VL-Amber Popcorn) recorded significantly higher maize equivalent yield during 2015 and 2016 (165.57 q/ha and 117.03 q/ha, respectively) as compared to variety T<sub>10</sub> (Amber Popcorn). Further data revealed that among the local varieties during 2015, there was no significant difference in maize equivalent yield, however, during 2016 variety T<sub>12</sub> (Farmer Selection) recorded significantly higher maize equivalent yield (54.25 q/ha) as compared to variety T<sub>11</sub> (Navjot). Maize equivalent yield of different maize varieties varied due to difference in market prices. It was calculated by Bandyopadhyay (1984). Layek *et al.* (2017) showed differential response of maize varieties under organic production system.

**Net return:** The results revealed (Table 2) that variety T<sub>9</sub> (VL-Amber Popcorn) recorded maximum net return during 2015 and 2016 (₹ 218120/ha and 139741/ha, respectively) as compared to other maize varieties. Simultaneously, among the grain maize varieties, variety T<sub>3</sub> (PHM-3) recorded higher net return (₹ 88171/ha and 84465/ha, respectively) as compared to variety T<sub>2</sub> (PM-9) and T<sub>1</sub> (PQPM-1). Further, among the sweet corn varieties, variety T<sub>4</sub> (Sugar-75) gave higher net return (₹ 96610/ha and 47335/ha, respectively) in comparison to other varieties. In the group of baby corn varieties, variety T<sub>7</sub> (PM-3) gave higher net return (₹ 21258/

ha and 35706/ha, respectively) in comparison to variety T<sub>8</sub> (PM-5). The local varieties of maize resulted that, variety T<sub>12</sub> (Farmer Selection) recorded higher gross return (₹ 54716/ha and 65500/ha, respectively) as compared to variety T<sub>11</sub> (Navjot).

**B:C ratio:** The research study revealed that the variety T<sub>9</sub> (VL-Amber Popcorn) recorded maximum BC ratio during 2015 and 2016 (4.96 and 3.54, respectively) followed by variety T<sub>3</sub> (PHM-3) (2.58 and 2.51, respectively), variety T<sub>4</sub> (Sugar-75) (2.23 and 1.60, respectively) and variety T<sub>1</sub> (PQPM-1) (2.08 and 2.27, respectively).

Hence, it has been concluded from the research study that variety T<sub>9</sub> (VL-Amber Popcorn) during 2015 and 2016 recorded significantly maximum maize equivalent yield (165.57 q/ha and 117.03 q/ha, respectively), net return (₹ 218120/ha and 139741 q/ha, respectively) and BC ratio (4.96 and 3.54, respectively) among different varieties of maize grown under organic production system.

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