

## Comparative Study on Yield Potential, Nutrient Uptake and Economic Profitability of Different Maize Hybrids under Kymore Plateau and Satpura Hill Zone of Madhya Pradesh

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**Abstract** A field experiment was conducted during the year 2012 consisting of seven newly developed maize hybrids and one composite variety for comparing yield potential, nutrient uptake and economics in rainfall condition. The results of present study revealed that, the hybrid Proagro Ly 620 produced significantly highest grain yield (65.69 q ha<sup>-1</sup>) and stover yield (152.51 q ha<sup>-1</sup>) as compared to the other tested hybrids. However, the lowest grain yield (19.44 q ha<sup>-1</sup>) and stover yield (53.43 q ha<sup>-1</sup>) was produced by hybrid Proagro 4212. Similarly, the uptake of N, P and K were found significantly highest of 251.80 kg ha<sup>-1</sup>, 75.79 kg ha<sup>-1</sup> and 287.86 kg ha<sup>-1</sup> respectively in hybrid Proagro Ly 620. However, the hybrid Proagro 4212 had the significantly lowest total N, P and K uptake of 52.31 kg ha<sup>-1</sup>, 19.81 kg ha<sup>-1</sup> and 60.55 kg ha<sup>-1</sup> respectively. The economic analysis of study showed

that, the hybrid T<sub>1</sub> i.e., Proagro-Ly 620 observed significantly highest GMR, NMR and B:C ratio of Rs 88624 ha<sup>-1</sup>, Rs 60185 ha<sup>-1</sup> and Rs 3.12 respectively as compared to other hybrids of maize. The GMR, NMR and B:C ratio was found in decreasing order with hybrids T<sub>5</sub>, T<sub>2</sub>, T<sub>4</sub>, T<sub>8</sub>, T<sub>6</sub> and T<sub>7</sub>. The hybrid T<sub>7</sub> i.e., Proagro 4212 lowest GMR, NMR and B:C ratio.

**Keywords** Maize hybrids, Nutrient uptake, Monetary return, B:C ratio.

### Introduction

Maize (*Zea mays* L., 2n = 20) belongs to family *poaceae* and grown as multipurpose as multipurpose crop in the world. It considered as queen of the cereal is one of the most important cereal crop in the world, next only to rice and wheat. The unique energy capturing capacity and efficient use of CO<sub>2</sub> as C<sub>4</sub> plant have made it capable of producing maximum grain yield per unit area as compared to all other cereal crops. Maize is globally a top ranking cereal not only in productivity but also as human food, animal feed and as a source of large number of industrial products. In India maize is grown in 8.26 million hectare area with the production of 16.72 million tones and productivity is 2024 kg ha<sup>-1</sup>. Whereas, in Madhya Pradesh, it is grown in 0.83 million hectare area with production of 1.05 million tones and productivity is 1256 kg ha<sup>-1</sup> [1]. In India 55% of the grain produce concurrently is used for food purposes, about 14%

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for livestock feed. 18% for poultry feed, 12% for starch and 1% for seed. By the end of this century the expected demand will be around 46% for food, 14% for livestock feed, 19% for poultry feed, 19% for starch industry and 15% for seed.

The potential for enhanced use of maize for special purposes based on existing uses and new products to meet the needs of a future generation provides the researchers with unique challenges. Thus, the father of green revolution, the renowned Noble Laureate, Dr. Norman E. Borlaug, believes that “after the last two decades saw the revolution in rice and wheat, the next few decades will be known as maize era”. It is a solution for emerging problems of depleting water table, labor shortage, low farm profitability, food security and climate change to make it as an alternative crop for the diversification and livelihood security due to its various types and uses. At present yield level is much lower than the potential of our existing varieties. A main constraint to enhance maize productivity is selection of unsuitable cultivars under a given set of environments.

Adoption of high yielding suitable hybrids not only improves the grain yield and its quality but also leads to higher income per hectare as compared to conventional varieties of maize. Modern maize hybrids have greater potential as compared with older hybrids. Maize hybrids usually have high yield potential than Open pollinated varieties due to hybrid vigor [2]. Since the yield potential of our existing varieties is deteriorating day by day, so the selection of good varieties with high potential and wide range of adaptability is highly essential and tolerance to biotic and abiotic stresses. The likely cause for high yield in modern hybrids has been more cob bearing plants per unit land area without reduction in grain per cob. To evaluate maize varieties in various agro-ecological zones for their adaptation, yield potential, nutrient consumption and economics so as to release suitable varieties for cultivation on farmers fields [3]. It is, therefore, imperative to understand the relationship among yield, nutrient uptake and economic viability with testing locations for better adaptation of hybrids to different production environments.

## Materials and Methods

The present experiment was laid out at Research Farm, JNKVV Jabalpur (MP) during *khariif*, 2012. The experimentation site lies between 23°91' North Latitude, 79°58' East Longitude with an altitude of 411.78 meters above the mean sea level, which comes under the agro-climatic zone classified as Kymore Plateau and Satpura Hill Zone of Madhya Pradesh, India. The soil of experimental field was clayey and neutral (7.3) with neutral electrical conductivity (0.31 dSm<sup>-1</sup>) and medium in available N (395 kg ha<sup>-1</sup>), P (17.85 kg ha<sup>-1</sup>) and organic carbon (0.64%) and high in available K (301 kg ha<sup>-1</sup>). The seven newly developed maize hybrids viz., Proagro-Ly 620, Proagro SAMPPANN, Proagro 4644, Proagro 4640, Proagro 4558, Proagro 4794, Proagro 4212 and one composite HQPM 1 were tested as treatments T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>, T<sub>5</sub>, T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub> respectively in randomized complete block design (RCBD) with three replications, having a net plot size of 4.0 m × 2.4 m. The sowing was done with the help of dibbler using seed rate of 18 kg ha<sup>-1</sup> with planting geometry 25 cm × 60 cm on 7 July 2012. Fertilizer was applied @ 120 kg N, 60 kg P and 40 kg K ha<sup>-1</sup>. Full dose of P and K were applied as basal in all treatments. 50% nitrogen was applied as basal at the time of sowing, while 25% nitrogen top dressed at knee height stage and remaining 25% nitrogen at tasseling stage. The package of recommended practices was adopted to maintain the crop.

For estimation of nitrogen, phosphorus, potassium concentration in grain and stover, the representative sample was taken at the time of threshing. The dried grain and stover sample was ground to fine powder with the help of mortar and pestle as well as electrical grinder for estimating the nutrient content. Nutrient content (N, P and K) in grain and stover were determined using standard method as Nitrogen in plant sample was determined by micro kjeldhal digestion and distillation method. Phosphorus was estimated by Vanado-molybdo phosphoric acid yellow color method [4] and the Potassium determination is based on measurement of spectral line intensities of potassium atoms excited when passing through a flame. The wave lengths of spectral line are proportional to the concentration of atoms of that element [5]. The total uptake of nitrogen, phosphorus and

**Table 1.** Grain and stover yield of different maize hybrids on per hectare area basis.

Tr. No.	Treatments (Maize hybrids)	Grain yield (q/ha <sup>-1</sup> )	Stover yield (q/ha <sup>-1</sup> )
T <sub>1</sub>	Proagro Ly 620	65.69	152.51
T <sub>2</sub>	Proagro SAPPMANN	46.53	110.43
T <sub>3</sub>	Proagro 4644	25.29	83.51
T <sub>4</sub>	Proagro 4640	41.66	104.43
T <sub>5</sub>	Proagro 4558	53.82	135.55
T <sub>6</sub>	Proagro 4794	29.43	94.05
T <sub>7</sub>	Proagro 4212	19.44	53.43
T <sub>8</sub>	HQPM 1	32.93	101.67
	SEm±	2.29	2.73
	CD ( <i>p</i> = 0.05)	6.92	8.26

potassium at harvest in grain and stover was estimated by using the following formula:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\% in grain/stover} \times \text{grain/straw yield (kg/ha))}}{100}$$

The cost of cultivation was calculated on the basis of the market price of seed, fertilizer and labor. The gross monetary returns (GMR) is the value marketable produce which directly related to the quantity of the produce obtained and existing rate of marketable produce (both grain and stover) under a particular treatment. The net monetary returns (NMR) per hectare under each treatment were determined by subtracting the cost of cultivation of a particular treatment from the GMR of the treatment. Benefit-cost ratio is the index indicating monetary gains over each rupee investment under different treatments. It is also termed as profitability and it is calculated by using the following formula:

$$\text{Benefit cost ratio} = \frac{\text{GMR (Rs/ha/year)}}{\text{Cost of cultivation (Rs/ha/ year)}}$$

## Results and Discussion

### Grain and stover yield (q/ha<sup>-1</sup>)

It is clear from the results that, the genotypic effect on grain and stover yield was found significant (Table 1). The hybrid Proagro Ly 620 produced significantly highest grain yield (65.69 q ha<sup>-1</sup>) and stover yield (152.51 q ha<sup>-1</sup>) as compared to other tested hybrids. However, the significantly lowest grain yield (19.44 q ha<sup>-1</sup>) and stover yield (53.43 q ha<sup>-1</sup>) was produced by hybrid Proagro 4212. The grain yield per hectare is the final expression of physiological and metabolic activities of a plant and a product of cumulative action of all factors contributing to better growth viz. number of cobs plant<sup>-1</sup>, grains cob<sup>-1</sup> and seed index. The yield is a complex trait and exhibits continuous variation, such continuous variation being generally attributed to polygenic control. The yield is governed not only by polygene but also highly influenced by environmental fluctuations [6—9].

### Nutrient content and total uptake of major (NPK) nutrients

During the present study, different maize hybrids showed significant variation for the total uptake of major nutrients viz., N, P and K (kg ha<sup>-1</sup>). However, the nutrient content (%) viz., N, P and K in grains and stover were showed non-significant variations. The total uptake of N, P and K were found significantly highest of 251.80 kg ha<sup>-1</sup>, 75.79 kg ha<sup>-1</sup> and 287.86 kg ha<sup>-1</sup> respectively in case of hybrid Proagro Ly 620 as compared to other tested hybrids. However, the hybrid Proagro 4212 had the significantly lowest total N, P and K uptake of 52.31 kg ha<sup>-1</sup>, 19.81 kg ha<sup>-1</sup> and 60.55 kg ha<sup>-1</sup> respectively. It showed that, the hybrid Proagro Ly 620 is more responsive than all remaining tested hybrids on the same dose of fertilizer. Data on uptake of major (NPK) nutrients by the crop under a particular set of production technique reflect the quantity of nutrients absorbed or removed by the crop to reach its final stage. Normally the nutrients are removed by the crop through its biomass (grain + stover) production therefore, concentration of a nutrient in biomass and quantity of biomass production affect the total quantity of removal of a particular nutrient. Thus, the total uptake of any nutrient by both

**Table 2.** Nutrients content (%) and total uptake (kg ha<sup>-1</sup>) in grain and stover of maize hybrids.

Tr. No.	Treatments (Maize hybrids)	Nutrient content in grain (%)			Nutrient content stover (%)			Total nutrient uptake (kg ha <sup>-1</sup> )		
		N	P	K	N	P	K	N	P	K
T <sub>1</sub>	Proagro-LY 620	1.96	0.086	2.16	0.81	0.47	1.27	251.80	75.79	287.86
T <sub>2</sub>	Proagro SAMPPANN	1.87	0.081	1.98	0.76	0.43	1.02	171.29	50.90	197.22
T <sub>3</sub>	Proagro 4644	1.24	0.061	1.31	0.54	0.36	0.74	76.36	31.36	94.65
T <sub>4</sub>	Proagro 4640	1.84	0.077	1.89	0.66	0.37	0.86	145.27	41.52	168.18
T <sub>5</sub>	Proagro 4558	1.95	0.082	2.12	0.79	0.46	1.11	211.76	67.67	244.75
T <sub>6</sub>	Proagro 4794	1.74	0.076	1.85	0.75	0.42	0.87	121.76	41.77	136.08
T <sub>7</sub>	Proagro 4212	1.26	0.067	1.36	0.52	0.34	0.64	52.31	19.81	60.55
T <sub>8</sub>	HQPM 1	1.96	0.078	1.88	0.79	0.42	0.91	134.74	46.61	154.30
	SEm±	0.02	0.001	0.01	0.001	0.001	0.01	1.77	1.22	2.80
	CD ( <i>p</i> = 0.05)	NS	NS	NS	NS	NS	NS	5.35	3.68	8.47

crop components as a whole significantly differed mainly due to their biological yields [10].

Economics analysis of the different maize hybrids

#### *Cost of cultivation*

The package and practices for cultivation of maize crop is same for all treatments. The cost of cultivation varies due to cost of treatment applied, the treatment cost of hybrids are same up to treatment T<sub>7</sub> i.e., Rs 28439 ha<sup>-1</sup>. However, the cost of cultivation for hybrid HQPM 1 was less of Rs 27359 ha<sup>-1</sup> due to lesser price of seed (Table 2). Maize crop required an investment of Rs 26639 ha<sup>-1</sup> for common expenses in different operations and input.

#### *Gross monetary returns (GMR)*

The GMR is the value of marketable produce under each treatment. It is directly related to the quantity of the produce obtained and existing rate of marketable produce under a particular treatment. Different maize hybrid showed significant difference for GMR among themselves (Table 3). Significantly highest GMR was recorded by hybrid T<sub>1</sub> i.e., Proagro-Ly 620 (Rs 88624 ha<sup>-1</sup>) as compared to other hybrids of maize. The GMR was found in decreasing order with hybrids T<sub>5</sub>, T<sub>2</sub>, T<sub>4</sub>, T<sub>8</sub>, T<sub>6</sub> and T<sub>3</sub>. The significantly lowest GMR was recorded by hybrid T<sub>7</sub> i.e., Proagro 4212 (Rs 26849 ha<sup>-1</sup>).

These results are in close conformity with the findings of many workers [11—13].

#### *Net monetary returns (NMR)*

Among the eight different hybrids of maize, hybrid Proagro Ly 620 (T<sub>1</sub>) gave significantly highest NMR of Rs 60185 ha<sup>-1</sup> as compared to other test hybrids (Table 3). The next best treatment was Proagro 4558 with NMR Rs 44966 ha<sup>-1</sup>. The NMR found in decreasing order with hybrids T<sub>5</sub>, T<sub>2</sub>, T<sub>4</sub>, T<sub>8</sub>, T<sub>6</sub> and T<sub>3</sub>. The hybrid T<sub>7</sub> i.e., Proagro 4212 fetched the negative NMR of Rs -1590 ha<sup>-1</sup> among all hybrids. It shows that the treatment T<sub>7</sub> was not economically viable. The probable reason of negative NMR in T<sub>7</sub> i.e., Proagro 4212 may be due to higher expenditure incurred in cultivation and low yield was obtained in comparison to other hybrids [11, 12].

#### *Benefit : cost ratio*

The B : C ratio showed significant variation for the different maize hybrids (Table 3). The significantly maximum B : C ratio of Rs 3.12 was observed by hybrid Proagro Ly 620 (T<sub>1</sub>) as compared other hybrids. Whereas, the B : C ratio was observed significantly minimum of Rs 0.94 by hybrid Proagro 4212 (T<sub>7</sub>). Different hybrids were in descending order of T<sub>5</sub>, T<sub>2</sub>, T<sub>4</sub>, T<sub>8</sub>, T<sub>6</sub> and T<sub>3</sub>. The variation in B : C ratio was due to variation in gross monetary return obtained from dif-

**Table 3.** Economic analysis of different maize hybrids on per hectare area basis. Note : Cost of seeds, for all seven hybrid Rs 100 kg<sup>-1</sup> and for HQPM 1 Rs 40 kg<sup>-1</sup>, selling price of grain Rs 1175 q<sup>-1</sup> (MSP) and Stover Rs 75 q<sup>-1</sup>.

Tr. No.	Treatments (Maize hybrids)	Cost of cultivation (Rs ha <sup>-1</sup> )	Gross monetary return (Rs ha <sup>-1</sup> )	Net monetary return (Rs ha <sup>-1</sup> )	B : C ratio
T <sub>1</sub>	Proagro-Ly 620	28439	88624	60185	3.12
T <sub>2</sub>	Proagro SAPPMANN	28439	62955	34516	2.21
T <sub>3</sub>	Proagro 4644	28439	35979	7540	1.27
T <sub>4</sub>	Proagro 4640	28439	56783	28344	2.00
T <sub>5</sub>	Proagro 4558	28439	73405	44966	2.58
T <sub>6</sub>	Proagro 4794	28439	39284	10845	1.38
T <sub>7</sub>	Proagro 4212	28439	26849	-1590	0.94
T <sub>8</sub>	HQPM 1	27359	46318	18959	1.69
	SEm±	-	2721.53	2721.53	0.10
	CD ( <i>p</i> = 0.05)	-	8236.46	8236.46	0.29

ferent hybrids. These results are in close conformity with the earlier findings [11—13].

### Conclusion

It was conclude from the results that, the hybrid Proagro Ly 620 produced significantly highest grain yield and stover yield as compared to the other tested hybrids. Similarly, the nutrient content and total uptake of N, P and K were found significantly highest in hybrid Proagro Ly 620. From the economic analysis of study the hybrid Proagro-Ly 620 were more economical profitable in terms of GMR, NMR and B : C ratio of Rs 88624 ha<sup>-1</sup>, Rs 60185 ha<sup>-1</sup> and Rs 3.12 respectively as compared to other hybrids of maize.

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