Madras Agric. J., 99 (4-6): 259-262, June 2012
https://doi.org/10.29321/MAJ.10.100060

Productivity and Profitability of Pop Corn, Composite and Hybrid Maize (*Zea mays* L.) Under Low Nitrogen Stress in Mollisols of Uttarakhand

M.S. Pal and Amit Bhatnagar*
College of Agriculture,
G.B. Pant University of Agriculture & Technology, Pantnagar-263 145

A field experiment was conducted during *kharif* 2006 and 2007 at G. B. Pant University of Agriculture and Technology, Pantnagar to study the effect of nitrogen stress on productivity and profitability of pop, composite and hybrid corns in Mollisols of Uttarakhand. Significantly higher productivity and profitability was observed at 80 kg than 60 and 40 kg nitrogen application mainly because of better plant growth and yield attributes. Among the maize cultivars, 'Him-129' (hybrid) proved more productive and profitable than pop corn 'VL Amber' and composites 'Pragati' and 'Vivek-11'.

Key words: Composite, hybrid, maize, nitrogen stress, pop corn, productivity, profitability

Maize (*Zea mays* L.), third important cereal crop of India, is grown mainly for food, feed, fodder and its different kinds such as sweet corn, pop corn, baby corn and green corn are now popular world over. Maize in Uttarakhand is grown in diverse climatic and soil conditions ranging from *tarai* belt to higher Himalayan region on an area of 44,000 ha with production of 66,000 ton annually. But, most of the crop acreage lies in Mollisols which is characterized with low organic matter and nitrogen content that force farming communities of the region to apply heavy dose of nitrogenous fertilizers which in turn result in complex problems including imbalance soil fertility, incidence of insect pest, poor soil quality and finally low productivity and profitability.

The nutritional requirement varies with kind of corn types like composite, hybrid, pop corn and so on; therefore, their nutritional requirements vary. But local faming communities of *Tarai* and hills usually apply flat dose of nitrogen *i.e.* 100-120:60:40 N:P_2O_5:K_2O kg/ha irrespective of corn types, that not only reduces nitrogen use efficiency but also increases cost of cultivation (Kumar, 2009). It has also been observed that composites and pop corn require lower nutrition including nitrogen because of short duration of the crop. Hence, there is an urgent need to find out corn types and varieties suitable under low nitrogen conditions. Therefore, the field experiment was carried out to study the effect of nitrogen stress on productivity and profitability of pop, composite and hybrid corns in Mollisols of Uttarakhand.

Materials and Methods

Field experiments were conducted during *kharif* 2006 and 2007 at G. B. Pant University of Agriculture and Technology, Pantnagar. The soil was sandy loam in texture, neutral in reaction (pH 7.3), medium in organic carbon (0.57 %), low in available nitrogen (223.6 kg ha^{-1}), medium in available phosphorus (19.9 kg ha^{-1}) and potassium (147.8 kg ha^{-1}). The experiment consisted of three nitrogen levels *viz.,* 40, 60 and 80 kg ha^{-1} and four varieties namely 'VL Amber' (pop corn), 'Him-129' (hybrid), 'Vivek-11' (composite) and 'Pragati' (composite) fitted in split plot design keeping nitrogen levels in main plot and varieties in sub plot, and replicated thrice. The crop was raised as per recommended package and practices. The crop was sown on 25th July and 25th June in 2006 and 2007 and harvested on 31st October 2006 and 21st Sept 2007, respectively with 15 kg ha^{-1} seed rate in case of VL Amber (popcorn), 25 kg ha^{-1} 'Him-129' (hybrid) and 20 kg/ha 'Vivek-11' and 'Pragati' (composite). The crop geometry was 60 cm x 25 cm during both years. One third of N and full P_2O_5 (60 kg/ha) and K_2O (40 kg/ha) were applied as basal and remaining N was top dressed in two equal splits first at knee high and second at tasseling stage. Sources of nitrogen, phosphorus and potassium were urea, SSP and MOP, respectively. Pre-emergence application of Atrazine @ 1.0 kg a.i. ha^{-1} was done just after sowing for effective weed control. The samples of randomly selected five plants were taken from every plot for analysis of growth and yield parameters. Total rainfall during crop season in the years 2006 and 2007 was 682.2 and 1158.6 mm with number of rainy days 33 and 43, respectively. High rainfall during the year 2007 caused water logging and resulted in poor yield despite timely sowing. Cost of cultivation was calculated by taking current market

*Corresponding author email: bhatnagaramit75@gmail.com

prices of inputs while gross return was obtained by multiplying grain yield with market price. The B:C ratio was calculated by dividing the gross return by cost of cultivation.

Results and Discussion

Growth parameters

Plant growth suffered badly under low levels of nitrogen as evidenced with lower dry matter production and leaf area during both years. The highest plant dry matter as well as leaf area was recorded with 80 kg nitrogen at all growth stages (Table1). Poor plant growth at 40 kg nitrogen might be due to less availability of nitrogen which decreased vegetative growth and dry matter production. Adequate supply of nitrogen might have helped the maize plants to grow faster, which in turn put forth more photosynthetic surface and leaf area, thus contributing more dry matter with 80 kg nitrogen. Bangarwa *et al*. (1988) and Brar *et al.* (1989) also reported that increased level of nitrogen favored the plant growth and development.

Table 1. Effect of nitrogen levels and varieties on dry matter and leaf area per plant of corn

Treatment	Dry matter (g plant^{-1})						Leaf area (cm^2 plant^{-1})					
	30 DAS		60 DAS		Harvest		30 DAS		60 DAS		Harvest	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Nitrogen levels												
N_{40}	11.2	20.5	64.8	59.2	165.6	186	1813	2907	3738	3828	1783	1209
N_{60}	14.4	24.0	70.9	65.9	186.4	200	2136	3154	4190	4220	2029	1501
N_{80}	18.5	27.0	74.6	72.5	199.9	214	2488	3480	4733	4575	2153	1769
CD (0.05)	1.2	2.5	3.8	5.2	10.0	06	126	217	151	301	298	223
Varieties												
VL Amber (Popcorn)	16.2	28.2	61.7	62.1	164.9	182	2455	3794	3669	3881	1729	1334
Him- 129 (hybrid)	13.6	21.6	75.4	70.3	197.3	214	1977	2897	4790	4394	2329	1740
Vivek- 11 (Composite)	14.8	22.3	68.4	63.8	192.4	210	2288	3043	4355	4360	2142	1552
Pragati (Composite)	14.1	23.3	74.8	67.2	181.3	193	2217	2988	4105	4196	2104	1345
CD (0.05)	1.4	2.9	4.4	6.1	11.6	6.7	146	251	174	347	311	258

Different corn varieties *i.e.* hybrid, composite and pop corn exhibited differential pattern of growth. 'VL Amber' (pop corn) had faster growth at early stage and produced significantly higher dry matter and leaf area at 30 days after sowing (DAS) but with age advancement, its growth slowed down and exhibited significantly the least dry matter at 60 DAS and harvest. Initial growth of 'Him- 129' (hybrid) was slow but it improved with age and produced significantly higher dry matter and leaf area at harvest but was statistically similar to 'Vivek-11'.The genetic constitution of variety might be responsible for differential growth behavior. Ammaji and Surayanarayana (2000) also reported variations in growth of maize cultivars. Plant population is an important parameter for yield in corn as it does not share the trait of tillering and branching. Nitrogen levels did not affect total days required for 50 per cent tasseling and silking during both years indicating no effect of low dose of nitrogen on corn phenology. Owing to same maturity period, varieties did not vary significantly with respect to number of days required for 50 per cent tasseling and silking.

Yield parameters

Significantly higher cob length was recorded at 80 kg nitrogen during both the years *(*15.4cm) and that was also statistically on par with 60 kg nitrogen.

Table 2. Flowering, cob characters and plant population of corn as influenced by nitrogen levels and varieties

Treatment	Days to 50% tasseling		Days to 50% silking		Cob length (cm)		Cob girth (cm)		Plant population	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Nitrogen levels										
N_{40}	45	45	49	47	14.2	13.2	13.0	11.0	55092	53445
N_{60}	45	44	49	47	15.0	14.9	13.5	11.1	55671	53805
N_{80}	45	44	49	48	15.4	15.4	13.6	11.4	55324	53898
CD (0.05)	NS	NS	NS	NS	NS	1.2	NS	NS	NS	NS
Varieties										
VL Amber (Popcorn)	45	45	49	48	14.9	14.5	12.3	9.7	53550	54375
Him- 129 (Hybrid)	45	43	48	46	15.0	14.5	13.8	11.8	58333	53816
Vivek- 11 (Composite)	44	44	49	46	15.1	14.5	13.8	11.5	55093	52912
Pragati (Composite)	45	45	48	47	14.6	14.4	13.7	11.8	54475	53761
CD (0.05)	NS	NS	NS	NS	NS	NS	0.7	1.1	NS	NS

The lowest level of nitrogen (40 kg) produced significantly the lowest cob length. The cob girth did not vary statistically among nitrogen levels though the highest value was obtained at 80 kg nitrogen during both the years (Table 2). More supply of nitrogen might have helped in increasing the cob length by favoring the metabolic activity probably cell division and elongation. Singh (2003) was of similar opinion.'VL Amber' exhibited significantly the lower cob girth (12.3 and 9.7 cm, respectively), while 'Him-129', 'Vivek-11' and 'Pragati' had similar cob girth during both the years. However, variations in cob length were non significant.

Crop fertilized with 80 kg nitrogen being at par with 60 kg nitrogen exhibited significantly more 100-grain weight than 40 kg during both the years. Significantly higher grain weight per cob was recorded at 80 kg nitrogen and the lowest at 40 kg that remained statistically similar to 60 kg N. The higher value of 100-grain weight and grain weight per cob at 80 kg N may be attributed to better plant growth consequently better partitioning and translocation of sugars. Sen *et al.* (1999) also observed similar results. 'Him-129' being at par with 'Vivek-11' produced significantly more 100-grain weight than 'VL Amber' and Pragati during both the years. Grain weight per cob was significantly lower in hybrid 'Him-129' and pop corn 'VL Amber' during both the years, respectively.

Table 3. Influence of nitrogen levels and varieties on yield attributes, cob and grain yield of corn

Treatment	100- grain weight (g)		Grain weight/ cob (g)		Grain yield (kg ha^{-1})		Harvest Index (%)	
	2006	2007	2006	2007	2006	2007	2006	2007
Nitrogen levels								
N_{40}	21.48	18.34	66.5	60.0	2732	2338	38.8	37.1
N_{60}	22.56	19.41	68.8	65.3	3434	2998	37.8	37.5
N_{80}	23.86	20.78	73.3	71.4	3864	3085	37.6	37.6
CD (0.05)	2.00	1.45	2.9	5.5	170	405	ns	ns
Varieties								
VL Amber (Popcorn)	16.61	14.64	49.8	46.2	2700	2068	31.2	31.1
Him- 129 (Hybrid)	26.00	22.58	81.0	77.8	3994	3410	41.9	41.3
Vivek- 11 (Composite)	24.29	21.29	75.2	70.3	3437	2925	40.6	40.5
Pragati (Composite)	23.64	19.53	72.2	67.9	3244	2824	38.4	36.4
CD (0.05)	2.30	1.6	3.4	2.5	196	311	3.4	1.2

Grain Yield

The grain yield of corn was significantly higher at 80 kg N that had 12.5 and 41.4 and 2.9 and 31.9 per cent more than 60 and 40 kg N during 2006 and 2007, respectively (Table 3). Mishra *et al.* (1994) and Tyagi *et al.* (1998) also observed significant improvement in yield attributes with increasing nitrogen levels. The higher yield was due to more value of yield attributes viz., cob length, cob girth, 100-grain weight and grain weight per cob (Shivay and Singh, 2000). However, variations in grain yield between two years may be attributed to weather conditions prevalent during crop season particularly rainfall that caused water logging in 2007 and had severe adverse effect on corn yield. Nitrogen levels

Table 4. Effect of nitrogen levels and varieties on economics of corn cultivation

Treatment	Cost of cultivation (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio	
	2006	2007	2006	2007	2006	2007	2006	2007
Nitrogen levels								
N_{40}	13235	13895	32787	28056	19549	14161	2.47	2.01
N_{60}	13466	14126	41208	35976	27742	21850	3.06	2.54
N_{80}	13697	14357	46368	37020	32671	22663	3.38	2.57
CD (0.05)	-	-	2040	4860	2040	4860	0.05	0.34
Varieties								
VL Amber (Popcorn)	13166	13826	32400	24816	19234	10990	2.46	1.79
Him- 129 (Hybrid)	13766	14426	47928	40920	34162	26494	3.48	2.83
Vivek- 11 (Composite)	13466	14126	41244	35100	27778	20974	3.06	2.48
Pragati (Composite)	13466	14126	38928	33888	25462	19762	2.89	2.39
CD (0.05)	-	-	2352	3732	2352	3732	0.05	0.26

* Selling price of maize Rs. 1200/q

failed to bring significant variation in harvest index during both the years.

Hybrid 'Him-129' produced significantly higher grain yield and that was 16.2, 31.2 and 37.7 per cent more in 2006 and 16.6, 20.8 and 65.0 per cent more in 2007 than 'Vivek-11', 'Pragati' and 'VL Amber', respectively (Table 3). Being a hybrid, 'Him-129' showed inherent high genetic production potential and produced more yield than pop corn and composites. The lower yield of pop corn 'VL Amber' was due to lower value of yield attributes *viz;* cob girth, 100-grain weight and grain weight per cob. Shanti *et al.* (1997) also observed superiority of hybrids over composites. Harvest index recorded was significantly higher in 'Him-129' and the lowest in 'VL Amber'. The superiority of the hybrid could also be due to its inherent efficient sink mechanism. Significant hybrid effect for grain yield was also reported by Farnham (2001).

Economics

Application of higher nitrogen dose of 80 kg not only had higher cost of cultivation but also gave higher gross returns, net returns and B:C ratio during both years mainly because of higher grain yield (Table 4). Owing to maximum grain yield, Hybrid 'Him-129' gave the highest gross, net returns and B:C ratio in spite of higher cost of cultivation. These findings are in conformity with Kumar (2009).

Thus, it can be concluded that in *tarai* region of Uttarakhand, nitrogen must be applied in adequate amount for higher productivity and profitability. Under low nitrogen condition hybrids should be given preference over pop corn and composites.

References

Ammaji, P. and Suryanarayana, K. 2000. Evaluation of fodder maize varieties under different levels of nitrogen. *Andhra Agric. J.* **47**: 184-187.

Bangarwa, A.S., Kairon, M.S. and Singh, K.P. 1988. Effect of plant density and level and proportion of nitrogen fertilization on growth, yield and yield components of winter maize (*Zea mays*). *Indian J. Agric. Sci.* **58**: 154-156.

Brar, R.S., Narang, R.S., Singh, N. and Mahal, S.S. 1989. Effect of different irrigation and nitrogen levels on growth, yield, water-use and internal water potential of winter maize. *J. Res. Punjab Agric. Univ.* **26**: 193-203.

Farnham, D.E. 2001. Row spacing, plant density and hybrid effects on corn yield and moisture. *Agronomy J.* **93**: 1049-1053

Kumar, A. 2009. Influence of varying plant population and nitrogen levels on growth, yield, economics and nitrogen use efficiency of pop corn *(Zea mays everta sturt*). *Crop Res.* **37**: 19-23.

Mishra, B.N., Yadav, R.S., Rajput, A.I. and Pandey, S.M. 1994. Effect of plant geometry and nitrogen application on yield and quality of winter maize. *Indian J. Agron.* **39**: 268-269.

Sen, A., Singh, S.C., Sharma, S.N., Singh, A.K. and Pal, A.K.1999. Effect of sowing time, its pattern and fertility level on performance of CM 111 an inbred parent line of maize hybrid in winter season. *Indian J. Agric. Sci.* **67**: 690-693.

Shanti, K. Rao, Reddy, V. P., Reddy, M.S. and Sharma, P. S. 1997. Response of maize hybrid and composite to different levels of nitrogen. *Indian J. Agric. Sci.* **67**: 424-425.

Shivay, Y.S. and Singh, R.P. 2000. Growth, yield attributes, yields and nitrogen uptake of maize (*Zea mays* L.) as influenced by cropping system and nitrogen levels. *Ann. Agric. Res.* **21**: 494-498

Singh, V. 2003. Effect of intra-row spacing and nitrogen levels on yield of double cross maize hybrids. Thesis submitted to G.B. pant University of Agriculture and Technology, Pantnagar.

Tyagi, R.C., Singh, D. and Hooda, L.S. 1998. Effect of plant population, irrigation and nitrogen on yield and its attributes of spring maize (*Zea mays*). *Indian J. Agron.* **43**: 672-676.

Received: September 19, 2011; Accepted: February 3, 2012