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Article · April 2017

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Journal of Experimental Biology and Agricultural Sciences

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ISSN No. 2320 – 8694

INFLUENCE OF VARYING NITROGEN LEVELS ON GROWTH, YIELD AND NITROGEN USE EFFICIENCY OF HYBRID MAIZE (*Zea mays*)

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Received – February 27, 2017; Revision – March 31, 2017; Accepted – May 05, 2017
Available Online – May 12, 2017

DOI: http://dx.doi.org/10.18006/2017.5(2).134.142

KEYWORDS

Nitrogen

Yield traits

Yield

Hybrid maize

ABSTRACT

Present investigation was carried out at Natore Sugar Mills area, Natore, Bangladesh during 2014-15 to evaluate the growth and yield responses of hybrid maize varieties under different levels of nitrogen fertilization. Two hybrid maize varieties *viz.* BARI hybrid maize-7 and BARI hybrid maize-9 were tested under four nitrogen levels (N_0= without external nitrogen supply, N_1= 115 kg N ha^{-1}, N_2= 230 kg N ha^{-1}, and N_3= 345 kg N ha^{-1}). All recommendations agronomic practices were used for both the variety. Yield and yield traits (plant height, plant girth, total leaves $plant^{-1}$, effective leaves $plant^{-1}$, non-effective leaves $plant^{-1}$, total root $plant^{-1}$,straw weight $plant^{-1}$,cob length, grain free cob, cob girth, grain line cob^{-1}, total grain cob^{-1}, grain number $line^{-1}$,1000-grains weight, grain weight cob^{-1},grain yield, straw yield and biological yield) were measured during and on the completion of the study. BARI hybrid maize-9 achieved maximum yield (10.99 t ha^{-1}) and it was followed by the BARI hybrid maize-7 (10.37 t ha^{-1}). Results of study revealed that yield traits and final yield significantly increased with increasing nitrogen fertilizer from 0 to 345 kg ha^{-1}. Among various tested N-fertilizer doses, highest grain yield was obtained from the plot treated with N_3 treatment (345 kg ha^{-1}) but it was not statistically differing from the N_2 treatment (230 kg ha^{-1}). Therefore, N_2 treatment (230 kg ha^{-1}) could be recommended for variety BARI hybrid maize-9 as the best economical nitrogen level for maximum economical yield of maize.

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Peer review under responsibility of Journal of Experimental Biology and Agricultural Sciences.

Production and Hosting by Horizon Publisher India [HPI] (http://www.horizonpublisherindia.in/).

1 Introduction

Maize (*Zea mays* L.) ranked third among the world cereal crop production. Maize is a short duration, quick growing crop and has potential to produce high quantity grains per unit area (Akbar et al., 2008). Maize is grown for grain as well as fodder in tropical, sub-tropical and temperate regions of the world. Maize as a cereal, has multiple uses such as bread making, corn flakes, corn syrup, corn starch, textile, paper making and in other food industries (Kumar & Jhariya, 2013). Corn oil is suitable for human consumption due to the presence of un-saturated fatty acids (Khan et al., 2013). Average maize yield (6.56 t ha^{-1}) in Bangladesh is very discouraging farmers, due to the big gap exists between the actual and potential yield per unit area of the crop (AIS, 2017).

The nitrogen plays significant role in various physiological operations of maize. It extends the leaf area effectively, delaying senescence and essential for initiation of ear and kernel. Further, proper nitrogen supply also affect define maize sink capacity (Torbert et al., 2011), maintain functional kernels throughout the grain filling, affecting the number of developed kernels and final size of kernel (Hopf et al., 1992; John & Schmitt, 2007). The influence of N availability on essential agronomic traits of maize has been described by several investigations (McCullough et al., 1994; Evans, 2008). Among the various major nutrients required for proper plants, Nitrogen has a key role and particularly it has been proven for maize by various experiments (Subramanian et al., 2006; Carpici et al., 2010). The nitrogen requirement of maize is depend on weather conditions, soil type and crop rotation pattern (Blackmer, et al., 2009; Bundy, et al., 2011).

Nitrogen is considered as the nutrient that most frequently limits yield and plays an important role in quality of maize crops. It is almost deficient in most of the Bangladesh soils and most of the tropics (Jules et al., 2014). Singh et al. (2006) found that the biological yield, content and uptake of nitrogen in grain and straw of maize were highest with supply of nitrogen as urea in two split dressings. Sawi et al. (2013), and Omara & Kurtz (2009) observed that nitrogen had significant effects on chemical composition of leaves, plant height, number of leaves and internodes per plant, dry weight of shoot and root, cob number per plant, number and weight of cobs/m^2, weight of seeds per cob, final seed yield and straw yield. Gasim et al. (2011) found that the addition of nitrogen increased forage fresh and dry yield and increased crude protein percentage in the leaf and stem indicating vital role of nitrogen particularly on maize. Generally, the agronomic practices and environmental factors have an effect on the growth, yield and quality of maize (Abd el-wahed et al., 2015; Barutcular et al., 2016 a; Barutcular et al., 2016b; EL Sabagh et al., 2015 and EL Sabagh et al., 2017).

So far large numbers of experiments have been carried out throughout the world to find out the optimum level of nitrogen in maize. However, country specific researches have not yet been done on different level of nitrogenous fertilizer especially with hybrid maize varieties under local environmental and soil conditions. Therefore, the present study was undertaken to find out the response of different doses of nitrogen on growth and grain yield, N use efficiency and other agronomic traits of hybrids maize varieties in Bangladesh.

2 Materials and Methods

The experiment was conducted at Natore Sugar Mills area, Natore, Bangladesh during 2014-15 to find out the optimum nitrogen dose for maximum productivity of BARI hybrid maize-7 and BARI hybrid maize-9. The experimental site have non-calcarious dark grey and black flood plain soil (Chalan Bill lower land) under the Chalan Bill flood plain (AEZ 8). The soil of the study area is generally sandy clay loam, non-saline and non-sodic with pH 7.0 (FRG, 2012). The experimental area was under sub-tropical climate characterized by rainfall during the Rabi season (November to April) and low temperature with scanty rainfall during the season.

The treatments of the two factorial experiment consisted as (a) varieties: (BARI hybrid maize-7, & BARI hybrid maize-9) and (b) different nitrogen levels *viz.* (i) Control (N_0), (ii) 115 kg (N_1), (iii) 230 kg (N_2), and (iv) 345 kg N ha^{-1} (N_3). The nitrogen was applied using urea (46% N). The experiment factors (treatments) were organized in completely randomized block design and the treatments were replicatedthree times. The sowing time was in first week of November 2014. The plot size was 20 m^2 (5 m X 4 m). The field was fertilized with urea (as per treatment), triple super phosphate, muriate of potash, zypsum, and boric acid at the recommended doses. One third of urea and all other fertilizers were applied during final land preparation. As per treatment, the rest of two-thirds of urea were top dressed in two equal splits, one of the crown root initiation stage (50 days after sowing-DAS) and the other at panicle initiation stage (80 DAS).

Experimental crop was irrigated for three times at intervals of 20, 45 and 70 DAS. All necessary management practices were carried out as per standard recommendation for maize crop. All vegetative and reproductive parameters were recorded. Plant height, plant girth, total number of leaves $plant^{-1}$, effective leaves $plant^{-1}$, non-effective leaves $plant^{-1}$, total roots $plant^{-1}$, straw weight $plant^{-1}$, straw yield (t ha^{-1}) were measured during vegetative period. Data on different yield parameters such as cob length, cob grain free and cob girth were measured with measuring scale, and counted the grain line cob^{-1}, grain number $line^{-1}$, total grain cob^{-1}, and finally grain weight cob^{-1}, 1000 grain weight, grains yield (t ha^{-1}), straw yield (t ha^{-1}), and biological yield (t ha^{-1}) were weighed with electrical balance. The crop was harvested manually at full maturity. The harvested crop of the plot was bundled separately, tagged properly and bring to the clean threshing floor. The seeds and straw weight for each plot were recorded after sun drying and

weighed. Cobs were de-husked, dried, shelled and weighed with electric balance. The data were analyzed statistically using the analysis of variance (ANOVA) technique with the help of MSTAT-C (Gomez & Gomez, 1984) and Microsoft excel program, and mean differences were adjusted by Duncan's Multiple Range Test (DMRT).

3 Results and Discussion

3.1 Effect of Nitrogen fertilization of various growths attributes of corn

Nitrogen treatments significantly influenced the plant height in BARI hybrid maize-7 and BARI hybrid maize-9. Maximum plant height (269.3 cm) was achieved withN_3 (345 kg N ha^{-1}), which was significantly different from other two treatments. While, the lowest plant height (235.7 cm) was recorded in control treatment without nitrogen (Table 1). Jat et al. (2009) reported that the plant height of sweet corn was significantly improved with the increase in rate of nitrogen fertilizer from 50 per cent (60 kg N ha^{-1}) to 100 percent of the recommended doses of fertilizers (RDF) (120 kg N ha^{-1}) and application of 100 per cent RDF significantly produced more dry matter (137.95 g $plant^{-1}$) than 75 and 50 per cent RDF. Sahoo & Panda (2009) reported that plant height increased gradually with increasing the nitrogen levels. Similarly, Singh (2011) revealed that 150 kg ha^{-1}N produced the highest plant height in baby corn during summer while Thakur & Sharma (2009) reported that maximum plant height can be achieved at 200 kg ha^{-1} N for the same plant. This thing justifies that maximum amount of nitrogen for same crop varies with the study area. Like plant growth, plant girth also increased gradually with increasing nitrogen treatments. Nitrogen levels showed significant positive effect on plant girth in BARI hybrid maize-7 and BARI hybrid maize-9. The highest plant girth (12.00cm) was recorded in BARI hybrid-7 from the treatment containing 345 kg/ha nitrogen levels while the smallest plant girth (7.33) was in observed BARI hybrid-9 with 115 kg/ha nitrogen, which was statistically different from 345 kg/ha nitrogen levels (Table 1).

Result of present study are contradictory to the findings of Kumar (2008) and Ummed et al. (2012), those who achieved maximum plant girth by application of 120 kg/ha nitrogen in the form of urea with combined 30 kg/ha nitrogen through poultry manure. Similarly Suryavanshi et al. (2008) also achieved highest plant girth on the application of 150 kg N ha^{-1} and this was significantly differ from the treatment have 50 and 100 kg nitrogen ha^{-1} in case of traditional maize variety. Total leaves $plant^{-1}$of BARI hybrid maize-9 was significantly influenced by the treatments of nitrogen (Table 1). The highest total leaves $plant^{-1}$ (14.00) was produced in BARI hybrid maize-9 at 345 kg N ha^{-1}while the lowest (12.00) was obtained at controlled treatment (N_0) of BARI hybrid maize-7. Total leaves $plant^{-1}$ gradually increased with increasing nitrogen levels but there was no significant difference among the various treatments in case of BARI hybrid maize-7. Thakur et al. (2007) reported that growth parameters of inbred maize viz., total leaf, leaf area and the accumulation of dry matter/plant were improved by the increase nitrogen up to 150 kg N ha^{-1}.Nitrogen positively affected the effective leaves $plant^{-1}$ in both hybrids of maize (Table 1). The highest effective leaves $plant^{-1}$ (12.50 and 13.00) were observed with N_3 treatment in BARI hybrid maize-7 and BARI hybrid maize-9, respectively and the lowest effective leaves $plant^{-1}$ (9.63) were observed with N_0 treatment in BARI hybrid maize-7. BARI hybrid maize-9 produced higher number of effective leaves as compared to BARI hybrid maize-7 in all levels nitrogen treatments. Bindhani et al. (2007) stated that effective leaves gradually increased with increasing nitrogen levels in baby corn.

The number of non-effective leaves $plant^{-1}$was influenced by the action of nitrogen in BARI hybrid maize-7 and BARI hybrid maize-9. The effect of nitrogen on the non-effective tillers was opposite to as found in effective tillers (Table 2). The highest non-effective leaves $plant^{-1}$ (2.67 and 1.67) was produced in N_0 and the lowest non-effective leaves (1.00 and 1.00) was produced N_3 treatment, which were statistically differed from other nitrogen levels.

Table 1 Effect of nitrogen on the growth and growth performance of BARI hybrid maize-7 and BARI hybrid maize-9

Treatments	Plant height (cm)		Plant girth (cm)		Total leaves $plant^{-1}$		Effective leaves $plant^{-1}$	
	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9
N_0	235.7^{d}	236.3^{d}	8.17^{bc}	7.50^{de}	12.00^{b}	12.30^{b}	9.63^{d}	10.93^{c}
N_1	$245.3b^{c}$	246.3^{bc}	7.67^{cde}	7.33^{e}	12.67^{b}	12.53^{b}	11.33^{ab}	11.33^{ab}
N_2	249.0^{b}	256.3^{b}	8.00^{bcd}	7.83^{cde}	12.67^{b}	13.00^{b}	11.67^{ab}	12.00^{a}
N_3	267.7^{a}	269.3^{a}	12.00^{a}	8.50^{b}	13.50^{ab}	14.00^{a}	12.50^{a}	13.00^{a}
LSD (0.05)	14.74		0.59		0.98		1.51	
CV (%)	3.32		4.04		4.42		8.63	

Results given in table are the mean of three replications, in a column figures having common letters(s) do not differ significant as per DMRT

Table 2 Effect of nitrogen on the growth and growth performance of BARI hybrid maize-7 and BARI hybrid maize-9

Treatments	Non-effective leaves plant^{-1})		Total roots plant^{-1}		Straw weight plant^{-1}	
	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9
N_0	2.67^{a}	1.47^{bc}	41.33^{b}	41.67^{b}	849.3^{e}	835.0^{e}
N_1	1.33^{c}	1.33^{c}	40.00^{b}	40.67^{b}	1010^{d}	1050^{d}
N_2	1.17^{cd}	1.30^{cd}	41.33^{b}	46.00^{a}	1266^{c}	1396^{ab}
N_3	10.37^{ab}	10.99^{a}	45.33^{a}	48.00^{a}	1346^{b}	1430^{a}
LSD (0.05)	0.82		3.10		50.79	
CV (%)	18.25		4.12		2.53	

Results given in table are the mean of three replications, in a column figures having common letters(s) do not differ significant as per DMRT

Table 3 Effect of nitrogen on the yield and yield attributed traits of BARI hybrid maize-7 and BARI hybrid maize-9

Treatments	Cob length (cm)		Grain free cob		Cob girth (cm)		Grain line cob^{-1}	
	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9
N_0	23.00^{c}	24.00^{bc}	1.67^{ab}	2.33^{a}	13.83^{b}	14.33^{b}	12.33^{c}	13.00^{bc}
N_1	25.33^{b}	26.00^{b}	1.33^{ab}	1.78^{ab}	15.00^{a}	15.00^{a}	13.33^{abc}	13.67^{ab}
N_2	27.00^{ab}	27.13^{ab}	0.67^{b}	1.00^{b}	15.33^{a}	15.33^{a}	13.67^{ab}	13.67^{ab}
N_3	27.79^{a}	28.33^{a}	1.33^{ab}	1.63^{ab}	15.80^{a}	15.97^{a}	14.33^{a}	15.03^{a}
LSD (0.05)	2.30		1.22		1.09		1.05	
CV (%)	5.09		5.20		4.07		4.05	

Results given in table are the mean of three replications, in a column figures having common letters(s) do not differ significant as per DMRT

These results are in agreement with the findings of Nath et al. (2009) who observed that dry leaves gradually decreased with increasing nitrogen in maize. Tohidi et al. (2012) recorded maximum none effective leaves of maize crop with 150 kg N ha^{-1}. BARI hybrid maize-9 produced less non-effective leaves than in BARI hybrid maize-7. Nitrogen significantly influenced the total roots plant^{-1} BARI hybrid maize-7 and BARI hybrid maize-9 (Table 2). The highest number of roots (48.00) was reported in BARI hybrid maize-9 with N_3 treatment while the lowest roots (40.00) were in N_1 treatment for both the varieties. This result might probably be due to more nitrogen enhanced more nutrients uptake especially nitrogen, which boosted more root production. Bruns & Abbas (2005) stated that application of full amounts of N fertilizer prior to sowing may result in better root development over carrying out N split applications. The straw weight plant^{-1} was remarkably increased with the increasing nitrogen levels in both varieties (Table 2). BARI hybrid maize-9 produced the highest straw weight plant^{-1} (1430.0g) in the treatment of N_3 while the lowest in N_0 treatment. Enhancement of nitrogen application augmented more vegetative growth resulting more dry matter production. Kumar (2009) observed that successive increasing of nitrogen rate from 0 to 120 kg/ha remarkably increased dry weight plant^{-1} in popcorn. The most efficient time of N application in maize crop at vegetative growth stage (V6) as reported by Wells & Blitzer (1984), and Wells et al. (2012).

3.2 Effect of Nitrogen fertilization of various yields attributes of corn

Like various growth attributes, various yield parameters also affect by the application of nitrogen fertilizers. Among this, cob length was significantly influenced by nitrogen treatments in BARI hybrid maize-7 and BARI hybrid maize-9, and longest cob length was observed in BARI hybrid maize-9 (Table 3). The maximum length for cob (28.33 cm) was achieved by application N_3 treatment, which was statistically similar with N_2 treatment. The lowest cob length (23.00 cm) was found in treatment N_0, which was statistically differs from other two treatments in both varieties. Thakur & Sharma (2009) observed that the maximum cob length with application of 200 kg N ha^{-1} as compared to 100 kg N ha^{-1}. In contrary to this, Pandey et al. (2010) did not found any positive variation in the length of baby corn with increasing of nitrogen rate from 60 to 120 kg Nha^{-1}. The cob grain free length showed insignificant variations among the nitrogen treatments in BARI hybrid maize-7 and BARI hybrid maize-9 (Table 3). The highest grain free cob length (1.67cm and 2.33cm) found with N_0 and the lowest (0.67cm and 1.33 cm) obtained N_2 treatment

in both varieties of BARI hybrid maize-7 and BARI hybrid maize-9, respectively. The cob grain free values decreased with the increasing of nitrogen levels up to N_2 treatment and thereafter increased in both varieties. The increased cob grain free length might be due to increased nitrogen levels enhanced more grains in cob which reduced the length of free cob grain space. Similar results were also reported by Kar et al. (2006) in maize crop. Cob girth of BARI hybrid maize-7 and BARI hybrid maize-9 was significantly influenced by different levels of nitrogen (Table 3). The cob girth increased with increasing nitrogen levels. BARI hybrid maize-9 produced the highest cob girth (16.67 cm) in N_3 treatments, which haven't significant difference with N_2 and N_1 treatments. The lowest cob girth was obtained where no nitrogen (N_0) were used. The increment of cob girth might be due to the supply of sufficient nitrogen. Singh et al. (2010a) observed that adding of 180 kg of N ha^{-1} compared to 60 kg of N ha^{-1}positively improved cob girth in baby corn. Similarly, Raja (2011) observed that the increase in nitrogen rates application from 0 to 120 kg N/ha positively improved the cob girth of sweet corn. The influence of nitrogen levels was significant on the grain line cob^{-1} in BARI hybrid maize-7 and BARI hybrid maize-9 (Table 3). In both varieties, the highest value (14.33) was obtained from N_3 treatment, which was statistically not different from the rest two nitrogen levels (N_2 and N_1). The lowest grain line cob^{-1} (12.33 and 13.00) was found in BARI hybrid maize-7 and BARI hybrid maize-9, respectively at N_o treatment. The grain line values gradually increased with increasing nitrogen levels. It might be due to the application of more nitrogen improved crop growth which ultimately increased grains line cob^{-1}. Kang et al. (2005) observed that application of 100 kg N ha^{-1} was the optimum to achieve the optimum grain line cob^{-1} and yield of sweet corn.

The effect of different nitrogen levels was statistically important for the total grains cob^{-1} of BARI hybrid maize-7 and BARI hybrid maize-9 (Table 4). The highest total grains cob^{-1} were obtained from treatments of N_2 and N_3,while the lowest total grain cob^{-1} was obtained from N_0 treatment in both the varieties. Total grains cob^{-1} were increased with the increasing nitrogen levels. The optimum grains cob^{-1} was observed with application of 120 kg N ha^{-1} than that of with 60 and 90 kg N ha^{-1}in baby corn (Pandey et al., 2010). Adding of 120 kg N ha^{-1} in baby corn resulted in the maximum grains cob^{-1} and the yield of corn as well, which was 28.6, 52.2 and 178.7% higher than that of 80, 40 and 0 kg N ha^{-1}, respectively (Bindhani et al.,2007). It was observed that the application of 180 kg N ha^{-1} was positive improves in grains cob^{-1} and grain yield as compared to 60 kg N ha^{-1} (Singh et al., 2010b). Nitrogen treatments had significant effect on grain number $line^{-1}$ of BARI hybrid maize-7 and BARI hybrid maize-9 (Table 4). The maximum grain number $line^{-1}$ (56.00) was counted at N_2, which was statistically similar with N_3, while the lowest grain number $line^{-1}$ was obtained at N_0. Adding of 120 kg N ha^{-1} resulted in the optimum grain number/line of baby corn without husk compared to other rates of N treatments (Sahoo & Panda, 2007). Increasing of nitrogen levels increased the grain number $line^{-1}$ up to N_2 treatment and afterward it declined.

It was conformed that increasing nitrogen level increased yield in an optimum level. The effect of different levels of nitrogen was significant on 1000-grain weight in both the varieties BARI hybrid maize-7 and BARI hybrid maize-9 (Table 4). Significantly highest 1000-grain weight (273.4g) was recorded from N_3 in BARI hybrid maize-9 among all the nitrogen levels which was statistically similar with BARI hybrid maize-7. It might probably be due to use of increasing levels of nitrogen. The lowest 1000-grain weight (244.8g) was counted with no nitrogen (N_0) treatment in BARI hybrid maize-7, which was statistically identical with BARI hybrid maize-9 with the same nitrogen level. Thakur et al. (2007) observed that the maximum 1000-grain weight of baby corn/plant with application of 200 kg N ha^{-1}as compared to other nitrogen treatments on Alfisols of Bajura, Kullu valley, Himachal Pradesh, India. The highest length, weight of ear and number of ears per plant of baby corn were found at 120 kg N ha^{-1} (Sahoo & Panda, 2009).The cob length was significantly influenced by nitrogen treatments in BARI hybrid maize-7 and longer cob length was observed in BARI hybrid maize-9 (Table 4). Maximum grain weight cob^{-1} (204.0 g) was observed with N_3 treatment in BARI hybrid maize-9, which was statistically similar with BARI hybrid maize-7 under similar treatment condition. The minimum grain weight cob^{-1} (127.3 g) was counted without nitrogen fertilization in BARI hybrid maize-7, which was statistically similar with BARI hybrid maize-9 at N_0 treatment. Grain weight cob^{-1} was increased with the increasing nitrogen levels. It was conformed that nitrogen supply increased grain weight cob^{-1} in different studies. Mullins et al. (2009) found that 112 kg N ha^{-1} was sufficient for achieving the optimum grain weight cob^{-1}in sweet corn. The optimum weight of green cobs was produced by Akthar& Silva (2009)with 150 kg N ha^{-1}, Sahoo & Mahapatra (2014) with 120kg N ha^{-1}.

Nitrogen treatment showed positive effect on grain yield in BARI maize-7 and BARI hybrid maize-9 (Table 5).The highest grain yield (10.87 t ha^{-1}) was produced with N_3 treatment in BARI hybrid maize-9, which was statistically similar with N_2 treatment and statistically the lowest grain yield (6.19 t ha^{-1}) was recorded inN_0 treatment. Application of more nitrogen enhanced plant growth and yield contributing traits which might probably increased grain yield of hybrid maize. Sahoo & Mahapatra (2014) found that improved rates of nitrogen application from 60 to 180 kg ha^{-1}improved the yield of grain from 8.88 to 10.53 t ha^{-1}, respectively. Adding of 160 kg N ha^{-1} achieved maximum productivity in corn (Shanti et al., 2007; Muniswamy et al., 2007). Gormus et al. (2016) found that combination of 180 kg ha^{-1} nitrogen and 100 kg ha^{-1} potassium are appropriate to achieve the maximum yield of cotton crop. The maximum grain yield of fine rice produced with application of 150 kg ha^{-1} (Rashid et al., 2016).

Table 4 Effect of nitrogen on the yield and yield attributed traits of BARI hybrid maize-7 and BARI hybrid maize-9

Treatments	Total grain cob^{-1}		Grain number line^{-1}		1000-grains weight (g)		Grain weight cob^{-1}(g)	
	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9
N_0	515.3^{c}	541.3^{c}	44.67^{c}	45.00^{c}	244.8^{d}	252.1^{d}	127.3^{d}	131.7^{d}
N_1	671.00^{b}	674.30^{b}	49.33b^{c}	50.33^{bc}	260.7^{c}	259.0^{c}	172.0^{c}	171.3^{c}
N_2	744.00^{a}	741.70^{a}	54.67^{a}	56.00^{a}	262.4^{bc}	263.2^{bc}	194.3^{b}	195.7^{b}
N_3	742.70^{a}	746.70^{a}	50.00^{b}	53.00^{ab}	272.6^{a}	273.4^{a}	202.7^{a}	204.0^{a}
LSD (0.05)	48.25		4.40		11.40		4.46	
CV (%)	4.10		5.00		2.50		1.46	

Results given in table are the mean of three replicates, in a column figures having common letters(s) do not differ significant as per DMRT

Table 5 Effect of nitrogen on the yield and yield attributed traits of BARI hybrid maize-7 and BARI hybrid maize-9

Treatments	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		Biological yield (t ha^{-1})	
	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9	BARI hybrid maize-7	BARI hybrid maize-9
N_0	6.19^{c}	6.22^{c}	42.00^{d}	41.53^{d}	48.22^{d}	47.75^{d}
N_1	8.12^{b}	8.94^{b}	53.55^{c}	54.95^{c}	63.40^{c}	63.59^{c}
N_2	9.98^{b}	10.38^{ab}	62.49^{b}	64.28^{b}	72.47^{b}	74.00^{b}
N_3	10.37^{ab}	10.99^{a}	66.51^{a}	66.77^{a}	77.29^{a}	77.66^{a}
LSD (0.05)	1.17		1.98		1.85	
CV (%)	7.43		2.00		1.61	

Results given in table are the mean of three replicates, in a column figures having common letters(s) do not differ significant as per DMRT

To achieve the optimum yield and N use efficiencies of wheat might be applying 172.5 N kgha^{-1} with sprays 200 ml L^{-1}ascobien (Gharib et al., 2016). Nitrogen significantly influenced the straw yield in BARI hybrid maize-7 and BARI hybrid maize-9 (Table 5). The highest straw yields (66.51 and 66.77 t ha^{-1}) were obtained with N_3 treatment and the lowest straw yields (42.00 and 41.53t ha^{-1}) with N_0 treatment in BARI hybrid maize-7 and BARI hybrid maize-9, respectively. A significant improvement in the baby corn was increased with increasing the application of nitrogen rates from 100 to 200 kg ha^{-1}.The effect of different level of nitrogen on biological yield was significant in BARI hybrid maize-7 and BARI hybrid maize-9 and the highest biological yield was obtained from BARI hybrid maize-9 (Table 5).The maximum biological yield (77.66t ha^{-1}) was obtained with N_3 and no statistical variation was recorded with BARI hybrid maize-7. The lowest straw yield (47.75 t ha^{-1}) was counted in BARI hybrid maize-9 with N_0 and statistically differed from other treatments but similar with BARI hybrid maize-7. It was reported that continuous increasing in nitrogen rates from 80 to 120 kg ha^{-1} achieved markedly maximum of biological yield from 200.0 and 222.4% over control, respectively (Kumar,2009). Maximum biological yield of sweet corn was achieved with 150 kg N ha^{-1}(Rao & Padmaja, 2014).

Conclusion

Nitrogen levels had pronounced effect on growth and grain yield of hybrid maize. Further, yield and yield traits gradually increased with increasing nitrogen levels from 0 (N_0) to 345 kg ha^{-1} (N_3). Nitrogen application at 345 kg ha-^{1} produced the highest yield and yield traits, but in most of the cases it was statistically similar with 230 kg ha^{-}1 N. On the other hand, BARI hybrid maize-9 performed better than BARI hybrid maize-7 in all levels of nitrogen treatments. Accordingly, it might be summarized that BARI hybrid maize-9 could be cultivated by application of 230 kg N ha^{-1} to achieve the optimum economic benefit.

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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