OPEN ACCESS

Ology Press

Research

Advances in Agriculture and Environmental Science: Open Access

Yield and yield attributes of two exotic white maize hybrids at different agroclimatic regions of Bangladesh under varying fertilizer doses

Md. Jafar Ullah, M. M. Islam, Kaniz Fatima, M. S. Mahmud and M. Rafiqul Islam

Sher-e-Bangla Agricultural University, Dhaka, Bangladesh

Correspondence: Md. Jafar Ullah, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, Email jafarullahsau@gmail.com

Received: April 23, 2019 | **Published:** May 24, 2019

Abstract

A study was conducted in three different sites (Sher-e-Bangla Agricultural University, SAU of Dhaka; Dhamrai of Dhaka district and Fakirpara of Rangpur district) of Bangladesh to evaluate two white maize hybrids (PSC-121 and KS-510) under five different fertilizer doses (50, 75, 100, 125 and 150% of the recommended dose approved for hybrids) at SAU, while three doses (50, 100 and 125%) at Dhamrai and Rangpur. At SAU the variety KS-510 performed better showing significantly higher seed yield (7.762 t/ha), but at Rangpur the variety PSC-121 had higher seed yield (5.223 t/ha). At Dhamrai both the varieties showed identical seed yields (6.951 t/ha with PSC-121 and 7.051 t/ha with KS-510). Out of three sites the SAU had higher seed yield (the highest 7.762 t/ha) compared to other two sites. Dhamrai had higher seed yield (highest 7.057 t/ha) than that of Rangpur (the highest 5.223 t/ha). The seed yields was mainly attributed to the number of grains per cob and 100 grain weight. At SAU and Rangpur sites the recommended fertilizer dose (100%) showed the highest seed yields of 8.284 t/ha and 4.992 t/ha respectively). While at Dhamrai the highest fertilizer dose (125%) showed the highest seed yield (7.901 t/ha). The interaction treatment of the variety KS-510 and fertilizer dose 75% at SAU showed had the highest seed yield of 8.738 t/ha), while the variety PSC-121 gave the highest seed yields with 125% at Dhamrai (7.831 t/ha) and with the recommended dose at Rangpur was 6.000 t/ha.

Key words: White maize, variety, fertilizer, yield, agroclimatic regions.

Introduction

Maize has been being used as fodder and human food for centuries in many countries. It has also been used as human food contributing to human food Security.[1–3] Among the cereal crops, maize is comparatively a new crop in Bangladesh and after having been incepted during 1960 this crop was mainly used for research purpose although its inception was with the objective of human consumption.[4] At present its cultivated area accounts for 448,000 hectares producing 3.54 *million* metric tons in a year.[5] The maize has 72% starch, 10% protein, and 4% fat supplying an energy density of 365 Kcal/100 g.[6]

The hybrid maize species presently grown in Bangladesh is yellow. Besides, from the centuries, tribes in the hilly areas of Chittagong (Chittagong hill tracts, CHT) have been growing local landraces or landraces in jhum (mixed cropping) system for their own consumption as raw.[7–10] The hybrid varieties are much more productive showing an average yield of 6.906 t/ha,[11] whereas that of the local ones is below two tones at averaged soil and environmental condition.[10] Worldwide, the maize is the third most important food crop.[12] Of the world acreage under maize, the white maize covers only 12% worldwide which is mostly grown for supplying grains for human consumption.[13] White maize is a new crop in Bangladesh although Bangladesh Agricultural Research Institute (BARI) developed one open pollinated variety named Suvra which had white grains but was not familiar as 'white maize'.

Krishi Gobeshona Foundation in Bangladesh took an initiative to grow and popularize white grained maize with the view that towards fifties there may be a food shortage and worldwide white maize is more preferable than yellow one to use as human food.[14,15] Under this suspicion the food supply may not be satisfied by two C_4 crops, namely rice and wheat which are low productive than that of maize (C_4) in terms of per space grain production. The inception of white maize in Bangladesh is necessary as this species are extensively used as human foods and again the yellow maize since having been initiated even before 40 years ago, it has not been popularized yet used to be used as human food. And still now it is almost solely used as poultry and livestock feed.[9]

Along with the motivational activities of the KGF to increase the human consumption of maize grains, the activities also included 'generation of the production technologies.' The technologies currently available for yellow maize production may not be suitable for the production of white maize which were imported to grow in Bangladesh. So, it was necessary to optimize fertilizer needs of the white maize varieties as compared to the hybrid yellow maize ones.

In Bangladesh, almost all upland soils are low in organic matter and deficient in N. Soil organic matter has great influence on soil nitrogen status which also increases plant growth and yields.[16,17] Phosphorus is deficient mainly in calcareous soils of Ganges floodplain and acidic soils of terrace and hill areas.[18,19] In phosphorus deficient soil, maize responses positively to the applied phosphatic fertilizers.[20] Potassium (K) is not a great problem in floodplain areas, but is deficient in terrace and Piedmont soils,[21] where plants need it for their growth and grain filling.[22] Irrespective of the difference in the availability of N, P and K, it was observed that addition of these three nutrients was necessary

Citation: Ullah MJ, Islam MM, Fatima K, et al.Yield and yield attributes of two exotic white maize hybrids at different agroclimatic regions of Bangladesh under varying fertilizer doses. *Adv Agr Environ Sci.* (2018);2(2):65-71. DOI: 10.30881/aaeoa.00024

for getting higher yields of most of the crops. Sulphur and Zn is essential to be added in the irrigated rice based cropping patterns.[23,24] Boron was also reported to be deficient in some regions.[18] Magnesium is deficient in the coarse-textured soils of Old Himalayan Piedmont plain, Brown hill soils and Grey floodplain soils of the northern part of the country.[18] Although currently Ca is not in deficient, its reserve in many floodplain soils is depleting due to decalcification process. Deficiencies of Cu and Mn are also reported in some places although it is very rare.[18] From reviewing the above points it may be commented that the overall fertility status in Bangladesh soil is not standard which emphasizes to add the deficient plant nutrients from fertilizing materials.[18,25,26]

Fertilizer application in proper ratio is one of the cultural practices to boost maize productivity in fields where plant nutrients are deficient.[27] Application of fertilizer along with other agronomic practices regulates the grain number and grain weight. It has been reported in the earlier publications that a modern hybrid maize with moderate yield potential takes up 287 kg N, 50 kg P, 167 kg K, 26 kg S, 8 kg Zn and 1.3 kg B per ha.[28,29] BARI has optimized the fertilizer recommendations for specific crops along with that for hybrid maize recommending N-230, P–48.91, K-166.66, S-25, Zn-4.5 and Boron – 1.02 kg per hectare. However, Cultivars differ in their response to nutrient supply when planted in different geographical environments and soil conditions.[30] The nutrient demands of genotypes vary if the surrounding climatic factors change.[30] Further, testing a certain genotype(s) under specific environmental regions needs to be evaluated under other areas having dissimilar environmental parameters. Furthermore, genotypes may have potentials even to adapt or acclimatize to areas having dissimilar environmental parameters and soil conditions.[31] The crop responses to N, P, K. B, S and Zn depending on both the fertility status of soil and also on the fertilizer use efficiency; which in turn are also influenced by many other factors.[32–37] So, the present study was planned to optimize the recommended dose of the yellow maize for the production of white maize in different agroecological conditions.

Materials and Methods

Under a project using the KGF (Krishi Gobeshona Foundation) fund, two white maize varieties (PSC-121 and KS-510) were tested at three different sites. These sites had distinct soil series. One site was Sher-e-Bangla Agricultural University (SAU) farm which was situated at Dhaka (central Bangladesh) which has the soil series – Chiatta. The second site was the farmer's field at Suapur Union of Dhamrai Upazilla which was about forty kilometers away from Dhaka having soil series - Dhamrai and the third site was at the Fakurpara village of Rangpur Sadar district in the northern Bangladesh having soil series - Gangachara. Sher-e-Bangla Agricultural University Farm is situated at 243° 41′ N latitude, 90° 22′ E longitude, 8.6 m altitude above the sea level (Bay of Bengal), belonging to the Agro-ecological Zone "AEZ-28" of Madhupur Tract having brown terrace soil.[37] Dhamrai's geographical position is within 23° 49' and 24° 03' north latitudes and in between 90° 01' and 90° 15' east longitudes under the agro ecological zone (AEZ 8) of 'Young Brahmaputra Jamuna Floodplain' having predominantly alluvium *soil* of the Bongshi and Dholesshori rivers.[11,38] One of the major cropping pattern of this site is Rabi- jute-T. aman wherein the test was made during the winter season of 2015-16. Rangpur (central) site is located in between 25° 39' and 25° 50' north latitudes and in between 89° 05' and 89° 20' east longitudes. Its AEZ-3 is 'Tista Meander Floodplain' having the *soil* composition of mostly alluvial (80%) of the Teesta River basin.

The rainfall of Dhaka was 3, 14, 83, 26, 215, 210 and 406 millimeters, whereas that at Rangpur was 12, 0, 152, 20, 313, 451 and 707 millimeter respectively in the months of January, February, March, April, May, June and July of 2016.[10] Dhamrai is about 39 kilometer away from Dhaka and its rainfall data are not separately available. In Bangladesh the winter season's temperature is generally low and there is a plenty of sunshine. The temperature tends to increase from February as the season proceeds towards summer season. Rainfall seldom occurs during winter in the period from November to January and scanty in February to March (Figure 1). The sowing dates varied due to the varying nature of the cropping pattern of the respective sites and the attaining field capacity time of the soil. At SAU site, the land elevation is high which can be used for dry land crop production after the recession of monsoon rain in the month of October. The Dhamrai soil was medium high wherein the rainy season rice (T.aman) is harvested in the month of November and thereafter the winter crop can be sown. In Rangpur the land was medium high wherein the test was made and its cropping pattern was short duration winter rice-potato-maize. Based on these cropping patterns of the respective sites, the trials were made on October 30 2015 at SAU, December 7 of 2015 at Dhamrai and February 9 of 2016 at Rangpur site.

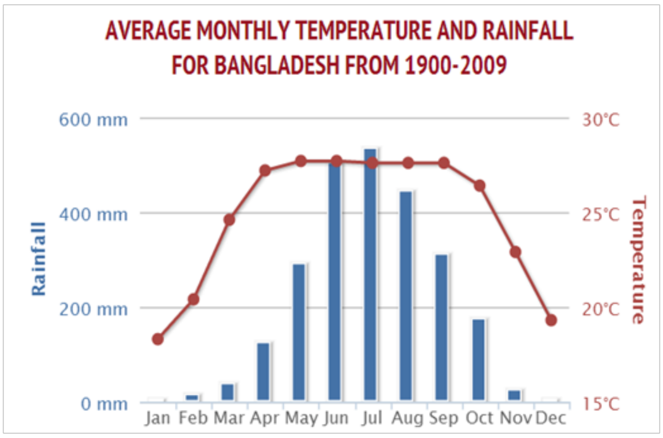

Figure 1 Average monthly temperature and rainfall for Bangladesh from 1900-2009. Figure reprinted from Islam[39] with data from the Climatic Research Unit of University of East Anglia (UEA)

The soil samples of SAU and Dhamrai sites were collected and analyzed at the Soil Resource Development Institute (SRDI) laboratory, Dhaka prior to the initiation of the experimentations. The secondary data regarding the soil status of Rangpur site have been collected from elsewhere.[40] From the soil analysis reports (Tables 1 and 2), it was observed that the soil of Dhaka and Dhamrai were silt loam having sand, silt and clay 27, 63,10% respectively at Dhaka, while 12,78,10% respectively at Dhamrai. That is the soil of the Dhaka was heavier than that of that at Dhamrai. The soil of Dhaka was more acidic having pH of 4.8 as compared to that at Dhamrai (5.1). There was more organic matter at Dhaka (an urban area) soil (1.48%) as compared to that of rural area of Dhamrai (1.08%). Although it is an obvious fact that organic maters are more available in the rural areas compared to those at the urban areas. However, Sher-e-Bangla Agricultural University have enough funds to collect its organic matter from the surrounding areas where a number of dairy farms are established. The lesser soil organic matter at Dhamrai may be attributed to the reduction in the livestock resources in the rural areas and also using dried cow dungs as fuel for kitchen purpose. In Bangladesh the cow dung is the main source of the organic matter which is applied in the soil in decomposed form. Likewise, the N status at Dhaka soil (0.074) was higher than that at Dhamrai soil (0.054%) which was obvious as the Dhaka soil had more added organic matter than that at Dhamrai soil.

Citation: Ullah MJ, Islam MM, Fatima K, et al. Yield and yield attributes of two exotic white maize hybrids at different agroclimatic regions of Bangladesh under varying fertilizer doses. *Adv Agr Environ Sci.* (2018);2(2):65-71. DOI: 10.30881/aaeoa.00024

Table 1 Soil analysis results of the SAU farm during pre-rabi season of 2016-17*

Texture	sand	Silt	Clay			
Silt loam	27%	63%	10%			
PH	Organic matter%	Total N%	Potassium%	Calcium%	Magnesium%	Phosphorus (mg/g)
4.8 Strongly acidic	1.48 Low	0.074 Very low	0.16 Low	4.52 Optimum	0.85 Medium	37.12 Very high
Sulphur (mg/g)	Boron (mg/g)	Copper (mg/g)	Iron (mg/g)	Manganese (mg/g)	Zinc (mg/g)	
15.70	0.06	4.21	236.85	42.2	4.07	
medium	Very low	Very high	Very high	Very high	Very high	

*Performed at SRDI lab, book no. 138, receipt no. 13794, 22/5/17

Table 2 Soil analysis results of Dhamrai farm during pre-rabi season 2016-17*

Textural class	Sand %	Silt %	Clay %			
Silt loam	12	78	10			
PH	Organic matter%	Total N%	Potassium%	Calcium%	Magnesium%	Phosphorus (mg/g)
5.1	1.08	0.054	0.12	9.45	2.21	3.13
Strongly acidic	Low	Very low	Low	Very high	Very high	Very low
Sulphur(mg/g)	Boron(mg/g)	Copper(mg/g)	Iron(mg/g)	Manganese(mg/g)	Zinc(mg/g)	
7.95	0.22	2.56	200.07	20.00	1.8	
Low	low	Very high	Very high	Very high	optimum	

*Performed at SRDI lab, book no. 138, receipt no. 13794, 22/5/17

The soil status at SAU was low in terms of potassium and boron (0.16% and 0.06 ppm respectively), optimum in terms of calcium (4.52%), medium in terms of magnesium and Sulphur (0.85% and 15.70 ppm) but higher in terms of phosphours (37.12 ppm), copper (4.21 ppm), iron (236.85 ppm), manganese (42.20 ppm) and Zinc (4.07 ppm). The soil status at Dhamrai was low in potassium (0.12%), phosphorus (3.13 ppm), Sulphur (7.95 ppm) and Boron (0.22 ppm), whereas was high in calcium (9.45%), magnesium (2.21%), copper (2.56 ppm), iron (200 ppm) and manganese (20 ppm). That is in terms of phosphorus, the Dhaka soil had extremely higher content which was in deficient in Dhamrai soil. Similar case was with Sulphur which was higher (medium) at Dhaka but lower at Dhamrai soil. Zinc was very high (like phosphorus) at Dhaka soil but its status at Dhamrai was optimum.

The soil of Rangpur (AEZ 3) was sandy clay loam in texture having sand, silt and clay of 51, 27 and 22% respectively which was much lighter than those of the other two sites. The pH was 5.5 which was a bit higher than that at Dhamrai and organic matter 1.59% which was remarkably higher than other two sites. The Rangpur site was basically in a rural area although was nearby a city corporation area 'Rangpur' wherein a number of poultry and dairy farms are established. Probably these two factors made an easy availability of organic matter to the farmers. The Rangpur soil had total N of 0.084% with available P of 6.0 mg/kg and these two nutrients were also low in comparison to those at Dhamrai. The Sulphur content at Rangpur was 11.9 mg/kg. The amount of the exchangeable bases such as K, Ca, Mg and Sodium were 0.24, 2.06, 0.90 and 0.36 meq/100 g soil, respectively. It may be mentioned here that N, P, K. S, Zinc and Boron is deficient in most of the Bangladesh soil which are added to the soil from different fertilizer sources.

Before planting, the land was harrowed four times and followed by laddering. At final land preparation the soil was provided with N, P, K, S, Zn and B from urea, triple super sulphate, muriate of potash, gypsum, zinc sulphate and boric acid as per the treatments based on the recommended dose of BARI.[40] Urea was splited at 30 and 45 days after sowing at equal rates just after irrigation when leaves were dried and there was no standing water on the soil surface. The trial was conducted in randomized complete block design with three replications maintaining row to row distance of 60 cm and plant to plant distance within each row 25 cm. Two seeds in each hill were sown, seeds germinated four days after sowing. The germinated weaker seedling was removed 15 days after emergence and weeding was done two times; 30 and 45 days after sowing. Irrigation was provided at 30 and 45 days after sowing and also in some other stages such as 60, 90 and 120 days after sowing whenever required depending on the soil moisture content (50% of field capacity). Other agronomic operations were done following the recommended packages of BARI.[40] Seeds were sown in furrows after having treated with Sevin 5G to protect seeds from soil containing pests. Treatments comprised two exotic hybrids imported from India (PSC-121 and KS-510) and five fertilizer levels in terms of % of as that recommended by BARI (F_{50} = 50, F_{75} = 75, F_{100} = 100, F_{125} = 125 and F_{150} = 150%). However, F_{50} = 50, F_{100} = 100 and F_{125} = 125 were tested at Dhamrai and Rangpur. Data were taken on different yield and yield attributes which were processed, analyzed using MSTAT C package and compared by LSD technique at 5% level of significance.

Citation: Ullah MJ, Islam MM, Fatima K, et al. Yield and yield attributes of two exotic white maize hybrids at different agroclimatic regions of Bangladesh under varying fertilizer doses. *Adv Agr Environ Sci.* (2018);2(2):65-71. DOI: 10.30881/aaeoa.00024

Results and discussion

Sher-e-Bangla Agricultural University

Plant height differed in the varieties. KS-510 had longer plant (197.83cm) than that of the PSC-121 (190.05cm) (Table 3). Likewise KS-510 had heavier seeds (29.93 g) than that of the PSC-121 (28.80g). The KS-510 cob contained more seeds (395.63) than that of the PSC-121 (363.12). The variety KS-510 had higher seed yield (7.762 t/ha) than that of PSC-121 (7.548 t/ha). The longest plant was obtained in the 100% of recommended fertilizer dose (199.58 cm) which was significantly higher than other fertilizer doses (186.88-195.21 cm) (Table 3). The lowest plant height was exhibited by the treatment 75% of the recommended dose. The significantly higher plant height values were obtained with the interaction treatment of F_{50}KS-510, F_{100}PSC-121 and F_{100}PSC-121 (201.67-205.24 cm) while the lowest plant height was obtained F_{75}PSC-121 (180.50 cm). Other treatments had the plant height values in between of the highest and lowest mentioned above. The highest 100 seed weight was obtained with F_{125}KS-510 (32.00 g) which was not significantly higher than those of F_{75}PSC-121 and F_{50}PSC-121 (31.33 and 30.67 g respectively). The lightest seeds were obtained with F_{150}KS-510 (28.67 g). The F_{125}KS-510 had significantly the most seeds in its cobs (445.07/cob) and the lowest was obtained in F_{75}PSC-121 (336.87/cob). The KS-510 with F_{75}while PSC-121 with F125 had significantly higher seed yields (8.738 and 8.867 t/ha respectively). Significantly the lowest seed yield was obtained with PSC-121 F_{75} (6.956 t/ha). PSC-121 at F125 produced the highest seed yield (8.867 t/ha) which however was not significantly higher than that of KS-510 at F75 (8.738 t/ha).

Dhamrai

The longest plants were obtained with the highest dose F_{125} at Dhamrai (236.33 cm) which was significantly longer than other others (200.67-209.58 cm) (Table 4). But the fertilizer dose 100-125% has statistically identical weight in 100 seed weight (29.33-29.83 g) which were significantly higher over that of the 50% (26.67 g). Significantly the highest number of grains was obtained with the highest fertilizer dose applied (393.43/cob) and the lowest (365.30/cob) with the lowest dose of 50%. Fertilizer significantly affected the yield of white maize at Dhamrai was with F_{125}% (7.901 t/ha) which was significantly higher than that of 100% (7.177 t/ha). The dose 50% had the lowest seed yield (5.933/ha) which was even significantly lower than 100% dose (7.177 t/ha). The grain yield was supported either by number of grain per cob or 100 seed weight (Table 4).

Table 3 Effect of different fertilizer doses on the yield and yield attributes of white maize at SAU during rabi 2015-16

Treatments	Plant height (cm)	Number of grain cob^{-1}	100 seed weight (g)	Yield (t/ha)
Varieties				
KS-510	197.83	395.63	29.93	7.762
PSC-121	190.05	363.12	28.80	7.548
LSD (0.05)	2.12	13.33	0.67	0.070
Fertilizer				
F_1=100% of recommended dose	199.58	393.33	30.33	8.284
F_2= 75% of recommended dose	186.88	364.30	30.83	7.847
F_3=50% of recommended dose	195.21	368.30	29.00	6.564
F_4=125% of recommended dose	192.38	411.20	27.67	7.998
F_5=150% of recommended dose	195.67	359.73	29.00	7.582
LSD (0.05)	3.36	21.08	1.06	0.110
Interaction				
F_{100} KS-510	197.50	390.27	31.33	8.204
F_{75} KS-510	193.25	391.73	30.33	8.738
F_{50} KS-510	204.25	386.40	27.33	6.711
F_{125} KS-510	192.50	445.07	32.00	7.129
F_{150} KS-510	201.67	364.67	28.67	8.027
F_{100} PSC-121	201.67	396.40	29.33	8.364
F_{75} PSC-121	180.50	336.87	31.33	6.956
F_{50} PSC-121	186.17	350.20	30.67	6.418
F_{125} PSC-121	192.25	377.33	23.33	8.867
F_{150} PSC-121	189.67	354.80	29.33	7.138
LSD(5%)	4.75	29.82	1.50	0.160

Citation: Ullah MJ, Islam MM, Fatima K, et al. Yield and yield attributes of two exotic white maize hybrids at different agroclimatic regions of Bangladesh under varying fertilizer doses. *Adv Agr Environ Sci.* (2018);2(2):65-71.
DOI: 10.30881/aaeoa.00024

Table 4 Effect of different fertilizer doses on the yield and yield attributes of white maize at Dhamrai, Dhaka during rabi 2015-16

Treatments	Plant height (cm)	Grain per cob	100 seed weight (g)	Yield (t/ha)
Variety				
PSC-121	214.06	378.00	27.67	6.951
KS-510	217.00	380.80	29.56	7.057
LSD (0.05)	**1.27**	**3.45**	**0.80**	**0.14**
Fertilizer				
F_{50} = 50% of recommended dose	200.67	365.30	26.67	5.933
F_{100} = 100% of recommended dose	209.58	379.47	29.33	7.177
F_{125} = 125% of recommended dose	236.33	393.43	29.83	7.901
LSD	**1.56**	**4.23**	**0.98**	**0.17**
Interaction				
F_{50} PSC-121	197.17	358.53	26.33	5.302
F_{100} PSC-121	210.67	378.80	28.00	6.817
F_{125} PSC-121	234.33	396.67	28.67	7.831
F_{50} KS-510	204.17	372.07	27.00	5.662
F_{100} KS-510	208.50	380.13	30.67	5.662
F_{125}KS-510	238.33	390.20	31.00	7.973
LSD (0.05)	**2.21**	**5.98**	**1.39**	0.25

The longest plant height was obtained with the variety KS-510 (217 cm) which was significantly higher than that of PSC-121 (214.06 cm) (Table 4). KS-510 had also the heavier seeds (29.56 g) compared to that of the PSC-121 (27.67 g). However the number of grains per cob was not found to be significantly different in KS-510 (380.80/cob) and PSC-121 (378.00/cob). Likewise the varieties did not show any significant difference in seed yields although KS-510 had higher seed yield (7.057 t/ha) than PSC-121 (6.951 t/ha).

Significantly the longest plant was with the interaction treatment F125KS-510 (238.33 cm) and the lowest with the lowest fertilizer dose F_{50} with PSC-121 (197.17 cm) (Table 4). Significantly the heavier seeds were obtained with KS-510 when grown using fertilizer dose from recommended (100% to 125%) showing the range of 30.67-31.00 g) and the lowest with F_{50}PSC-121 (26.33 g). But significantly more seeds per cob was obtained with F_{125}PSC-121 (396.67) and the lowest with F_{100} in PSC-121 (358.53). Significantly the higher seed yields were obtained with F125 fertilizer dose in both the varieties (7.831-7.973 t/ha). The lowest seed yield was obtained with F_{50}PSC-121 (5.302 t/ha).

Rangpur

The variety PSC-121 was significantly longer (227.52 cm) than the KS-510 (220.85 cm) (Table 5). The variety KS-510 had significantly lighter weight of seeds/cob (23.22) than that of the PSC-121 (24.44); and similar case was observed with the number of grains per cob which was more in PSC-121 (358.12) and lesser in KS-510 (342.67). Likewise the variety PSC-121 had more seed yield (5.223 t/ha) than that of the KS-510 (4.117 t/ha).

Fertilizer showed significant difference in seed yield and yield parameters at Rangpur site (Table 5). Significantly the longest plant was obtained in F_{125} (232.25 cm) while the shortest with the lowest dose 50% (216.22 cm). The recommended dose (100%) had significantly the heaviest seed weight (25.17g) which was higher than the other two doses which were 22.67 g and 23.67 g respectively with 50 and 125% fertilizer doses. Likewise the recommended dose of fertilizer had significantly highest number of seeds per cob (380.57) and 50% dose the lowest number (321.90/cob). Similar results were observed in case of seed yield where the recommended dose of fertilizer yielded the highest (4.992 t/ha) out yielding other two treatments showing significantly lower seed yields than the recommended (4.527 t/ha) with 50% and 4.491 t/ha with 125%).

Significantly the longest plant was seen with the interaction treatment of F_{125}PSC-121 (241.22 cm) and the shortest with F_{50}PSC-121 (213.33 cm). F_{100} with PSC-121 produced the heaviest seeds (26.00g) which significantly greatest of all other treatments (22.00-24.33 g). This treatment (F_{100}PSC-121) also had the most seeds in the cobs (393.16) which was significantly higher than others (314 – 368). Similarly the treatment F_{100}PSC-121 showed the highest seed yield (6.000 t/ha) which was significantly higher than the seed yields of other treatments (3.804-5.249 t/ha).

The response of crops mainly depends on the soil nutrient reserves especially to the extent of deficiency. Dhamrai site had more nutrient deficiency compared to other sites although the nutrient analysis did not demonstrate the fact. In a previous study at the south eastern hills of Bangladesh it was observed that the application of fertilizers at 100% and 50% of recommended rate produced identical but significantly higher grain yield compared to 25% of recommended rates.[41]

The interaction treatment of fertilizer and variety showed that at SAU the Fertilizer dose with KS-510 had the highest seed yield of 8.738 t/ha). But the variety PSC-121 gave the highest seed yields at other two

Citation: Ullah MJ, Islam MM, Fatima K, et al. Yield and yield attributes of two exotic white maize hybrids at different agroclimatic regions of Bangladesh under varying fertilizer doses. *Adv Agr Environ Sci.* (2018);2(2):65-71. DOI: 10.30881/aaeoa.00024

sites; with 125% at Dhamrai (7.831 t/ha) but with F_{100} at Rangpur (6.000 t/ha). So, it may be concluded that KS-510 with F_{75} at SAU while PSC-121 with F_{125} at Dhamrai and F_{100} at Rangpur might be grown for getting higher seed yields. Across the sites it was observed that the highest seed yields were obtained at SAU and was followed by Dhamrai and Rangpur. This may be attributed to the interaction of crop management factors and the soil attributes of the respective sites. These aspects are very complex which necessitated collecting all sorts of data relating to the crop management along with the soil attributes to explain results as obtained in these three sites.

Table 5 Effect of different fertilizer doses on the yield and yield attributes of white maize at Rangpur Sadar during rabi 2015-16

Treatment (Fertilizer)	Plant height (cm)	Grain per cob	100 seed weight (g)	Yield (t/ha)
Variety				
PSC-121	227.52	358.12	24.44	5.223
KS-510	220.85	342.67	23.22	4.117
LSD (0.05)	**6.30**	**7.81**	**0.71**	**0.17**
Fertilizer				
50% of recommended dose	216.22	321.90	22.67	4.527
100% of recommended dose	224.06	380.57	25.17	4.992
125% of recommended dose	232.28	348.89	23.67	4.491
LSD	**7.72**	**9.57**	**0.87**	**0.21**
Interaction				
F_{50} PSC-121	213.33	314.05	23.33	5.249
F_{100}PSC-121	228.00	393.16	26.00	6.000
F_{125} PSC-121	241.22	367.13	24.00	4.419
F_{50} KS-510	219.11	329.38	22.00	3.805
F_{100}KS-510	220.11	368.00	24.33	3.984
F_{125}KS-510	223.33	330.64	23.33	4.564
LSD (0.05)	**10.91**	**13.53**	1.24	**0.30**

Conclusion

Two exotic white maize varieties were tested at three different locations of Bangladesh under varying combinations of the recommended fertilizer doses (F100). The study revealed that the combination treatment F_{125}PSC-121 at SAU showed the highest seed yield (8.867 t/ha) which however, was statistically at par with that (8.738 t/ha) of F_{75}KS-510. So, at SAU KS-510 hybrid may be chosen to be grown using 75% of the existing recommended fertilizer doses. At Dhamrai the hybrid KS-510 showed the highest seed yield (7.973 t/ha) with F125% which however was not significantly higher than that (7.831 t/ha) of F_{125}KS-510. So, at this site any of both the hybrids may be cultivated using 25% increased fertilizer dose over the recommended doses. At Rangpur, the treatment F_{100}PSC-121 yielded significantly the highest seed yield (6.000 t/ha) over other treatments combinations. So, at this site the PSC-121 should be grown using the existing recommended dose of fertilizers.

References

1. Guruprasad M, Sridevi V, Vijayakumar G, Kumar MS. Plant regeneration through callus initiation from mature and immature embryos of maize (Zea mays L.). 2015.
2. Dogan Y, Ekinci MB, Togay N, Togay Y. Determination of suitable nitrogen doses for growing second product maize (Zea mays L.) varieties in chickpea planting fields and its economic analysis. *Indian J Agric Res*. 2015;49(2):125–133.
3. Katinila N, Verkuijl H, Mwangi WM, Anandajayasekeram P, Moshi AJ. *Adoption of Maize Production Technologies in Southern Tanzania*. CIMMYT; 1998.
4. Karim R. Studies on Maize in Bangladesh. *Int Food Policy Res Inst BFPP Dhaka*. 1992.
5. Hossain T. *Bangladesh Grain and Feed Annual Report*. USDA Foreign Agricultural Service; 2018.
6. Nuss ET, Tanumihardjo SA. Maize: a paramount staple crop in the context of global nutrition. *Compr Rev Food Sci Food Saf*. 2010;9(4):417–436.
7. Chakma SS, Ando K. Jhum cultivation in Khagrachari hill district of Bangladesh-a subsistence farming practices in ethnic minorities. *J Agrofor Env*. 2008;2(2):1–8.
8. Ullah MM, Malek MA, Karim MM, Ali MS. *A Report on Jhum Research in CHT*. Hill Agricultural Research Station Bangladesh Agricultural Research Institute, Khagrachari Hill District; 2012:3-20.
9. Ullah M, Islam MM, Fatima K, Mahmud MS, Rahman J. Evaluating yield and yield performance of transplanted white maize varieties under varying planting geometry. *J Expt Biosci*. 2016;7(2):21-30.

Citation: Ullah MJ, Islam MM, Fatima K, et al. Yield and yield attributes of two exotic white maize hybrids at different agroclimatic regions of Bangladesh under varying fertilizer doses. *Adv Agr Environ Sci.* (2018);2(2):65-71. DOI: 10.30881/aaeoa.00024

10. Ullah MJ, Islam MM, Fatima K, et al. Comparing Modern Varieties of White Maize with Landraces in Bangladesh: Phenotypic Traits and Plant Characters. *J Expt Biosci*. 2017;8(1):27-40.

11. Bangladesh Bureau of Statistics. *Yearbook of Agricultural Statistics of Bangladesh 2015*. Dhaka, Bangladesh: Government of Bangladesh; 2016.

12. Kyenpia E, Namo O, Gikyu S, Ifenkwe O. A comparative study of the biochemical composition of some varieties of maize (Zea mays) grown in Nigeria. *Niger J Bot*. 2009;22:291-296.

13. IITA. *International Institute for Tropical Agriculture Annual Report*.; 2005:20-32.

14. Cribb J. The Coming Famine: Risks And Solutions For Global Food Security. *ScienceAlert*. April 2010.

15. FAO, CIMMYT. White Maize: a Traditional Food Grain in Developing Countries. *UN Food Agric Organization FAO Int Maize Wheat Improv Cent CIMMYT Rome Italy*. 1997.

16. Nandasena KA. Nitrogen Status and its Supplying Capacity of Tropical Soils. In: *International Forestry and Environmental Symposium*. Sri Lanka: Department of Forestry and Environmental Science, University of Sri Jayewardenepura; 2000.

17. Abebe Z, Feyisa H. Effects of nitrogen rates and time of application on yield of maize: rainfall variability influenced time of N application. *Int J Agron*. 2017;2017.

18. Egashira K, Yasmin M. Sulfur Status of Bangladesh Floodplain Soils. *Bull Inst Trop Agric Kyushu Univ*. 1991;14:15-23.

19. Moslehuddin AZM, Laizoo S, Egashira K. Fertility status of Bangladesh soils-A review. *J Fac Agric Kyushu Univ*. 1997;41:257–267.

20. Duminda DMS, Kumaragamage D, Indraratne SP. Response of Maize (Zea Mays L.) to Phosphorus Fertilizers in Two Alfisols with Contrasting Phosphorus Availabilities and Sorption Capacities. *Commun Soil Sci Plant Anal*. 2018;49(10):1218–1228.

21. Islam M, Altamash S, Sarker N, Hossain KM. Potassium responses in greenhouse and field studies in Bangladesh. In: *International Symposium on Potassium in Agricultural Soils*. Soil Science Society of Bangladesh and Bangladesh Agricultural Research Council; 1985:70-89.

22. Nieves-Cordones M, Al Shiblawi FR, Sentenac H. Roles and transport of sodium and potassium in plants. In: *The Alkali Metal Ions: Their Role for Life*. Springer; 2016:291–324.

23. Islam M. Soil characteristics and their effects on sulfur and zinc deficiency problems in Bangladesh. In: Dhaka, Bangladesh; 1990.

24. Egashira K, Yasmin M. Total and available phosphorus of some floodplain soils of Bangladesh. *Bull Inst Trop Agric Kyushu Univ*. 1990;13:127–137.

25. Portch S, Islam M. Nutrient status of some of the more important agricultural soils of Bangladesh. In: *International Symposium on Soil Test Crop Response Studies*. Bangladesh Agricultural Research Council and Soil Science Society of Bangladesh; 1984:97-106.

26. Saheed S. Soils of Bangladesh. In: *International Symposium on Soil Test Crop Response Studies*. Bangladesh Agricultural Research Council and Soil Science Society of Bangladesh; 1984:107-129.

27. Bhuiyan N. Appropriate nutrient ratios for soils and crops of Bangladesh. Paper presented in the conference on Production and Use of Multinutrient Fertilizer in Bangladesh. In: Dhaka, Bangladesh: Bangladesh Agricultural Research Council; 1991.

28. Liu K, Ma BL, Luan L, Li C. Nitrogen, phosphorus, and potassium nutrient effects on grain filling and yield of high-yielding summer corn. *J Plant Nutr*. 2011;34(10):1516–1531.

29. Bender RR, Haegele JW, Ruffo ML, Below FE. Modern corn hybrids' nutrient uptake patterns. *Better Crops*. 2013;97(1):7–10.

30. Khuong TQ, Tan PS, Witt C. Improving of maize yield and profitability through site-specific nutrient management (SSNM) and planting density. *Omon Rice J*. 2008;16:88–92.

31. Hirth M, Dietzel L, Steiner S, et al. Photosynthetic acclimation responses of maize seedlings grown under artificial laboratory light gradients mimicking natural canopy conditions. *Front Plant Sci*. 2013;4:334.

32. Leenaars J, Ruiperez González M, Kempen B. *Extrapolation of Fertilizer Nutrient Recommendations for Major Food Crops in West Africa*. Wageningen, Netherlands: ISRIC - World Soil Information; 2018.

33. Vaughan A. The relation between the concentration of boron in the reproductive and vegetative organ of maize plants and their development. *Rhod J Agric Res*. 1977;15:163-170.

34. Ibrahim SA, Kandil H. Growth, yield and chemical constituents of corn (Zea Maize L.) as affected by nitrogen and phosphors fertilization under different irrigation intervals. *J Appl Sci Res*. 2007;3(10):1112–1120.

35. Smid AE, Peaslee DE. *Growth and CO2 [Carbon Dioxide] Assimilation by Corn as Related to Potassium Nutrition and Simulated Canopy Shading*.; 1976.

36. Hossain MA, Jahiruddin M, Khatun F. Response of maize varieties to zinc fertilization. *Bangladesh J Agric Res*. 2011;36(3):437–447.

37. Tajul MI, Alam MM, Hossain SMM, Naher K, Rafii MY, Latif MA. Influence of plant population and nitrogen-fertilizer at various levels on growth and growth efficiency of maize. *Sci World J*. 2013;2013.

38. UNDP, FAO. *Land Resources Appraisal of Bangladesh for Agricultural Development*. Rome: United Nations Development Programme and the Food and Agriculture Organization of the United Nations; 1988.

39. Islam M. Sustainable Development and South Asia: The Case of Bangladesh. In: *Sustainable Development: South Asian Conundrum*. Dhaka, Bangladesh: IIDS Australia, IIMS India and BEN Germany; 2015:6-36.

40. BARI. *Krishi Projukti Hath Boi (Handbook of Agriculture)*. Joydebpur, Gazipur: Bangladesh Agricultural Research Institute; 2011.

41. Akbar MA, Siddique MA, Marma MS, et al. Planting Arrangement, Population Density and Fertilizer Application Rate for White Maize (Zea mays L.) Production in Bandarban Valley. *J Agril For Fish*. 2016;5(6):215–224.

Citation: Ullah MJ, Islam MM, Fatima K, et al. Yield and yield attributes of two exotic white maize hybrids at different agroclimatic regions of Bangladesh under varying fertilizer doses. *Adv Agr Environ Sci.* (2018);2(2):65-71. DOI: 10.30881/aaeoa.00024