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Effect of Planting Arrangement on Nutrition and Nutrient Uptake in Maize

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Abstract: An experiment was conducted at the Bangladesh Agricultural University, Mymensingh, in the rabi season (November to April) to study the effect of variety and planting arrangement on nutrition and nutrient uptake in maize. Four maize varieties-Barnali, Khoibhutta, Mohor and Shuvra were planted in two plating arrangements-one plant per hill 25 cm apart (P_1) and two plant per hill 50 cm apart (P_2) in a constant row spacing of 75 cm. A split-plot design was used with three replications by placing variety in the main plot and planting arrangement in the sub plot. Results showed that both variety and planting arrangement had significant influence on nutrition and nutrient uptake in maize. Shuvra gave the highest grain yield (6.20 t ha^{-1}) followed by Manor 15.84 t ha^{-1}) and Barnali (5.59 t ha^{-1}). Stalk yield was the highest (7.21 t ha^{-1}) from Mohor. One plant per hill (P_1) produced more grain and stalk yield (5.72 t ha^{-1} and 6.45 t ha^{-1}, respectively) than P_2 (5.41 t ha^{-1} and 5.98 t ha^{-1} respectively). Nutrient content in grain differed significantly among the varieties but similar in both the planting arrangements (P_1 and P_2). In general, higher nutrient uptake by a variety appeared to correspond to its high grain yield. Planting arrangement also had influence on nutrient uptake. One plant per hill 25 cm apart caused more uptake than 2 plants per hill 50 cm apart. This study showed that the varieties Shurva and Mohor and one plant per hill 25 cm apart had higher nutrient uptake efficiency that resultant higher grain and stalk yield.

Key words: Planting arrangement, nutrient uptake, maize

Introduction

Increased food production can be achieved either by bringing more area under cultivation or by increasing yield per unit area. As the first possibility ie almost out of question in Bangladesh, food deficit has to be increased vertically i.e., per unit area. Maize can contribute most significantly in this respect because of its higher productivity per unit area than wheat and rice. The agro-climatic condition of Bangladesh is favourable for maize cultivation round the year. Keeping in mind this, Bangladesh Agricultural Research Institute (BARI) released four varieties of maize, namely, Bernell, Khoibhutta, Mohor and Shuvra.

The yield per unit area of a crop depends on four main factors sunlight, water, carbon dioxide and minerals (Parks, 1977). Spacing and planting arrangements of a crop can influence the availability of these inputs for the plants.

Maize has an open canopy. Maximum sunlight striking the surface of a maize crop penetrates the canopy. In many cases, 50% or more of this energy reaches the soil surface (Parks, 1977). Therefore, plant spacing in a maize field is important to ensure maximum use of solar energy by the plants and reduce the energy reaching the soil to minimize evaporation of valuable soil moisture. Besides, nutrient availability in the soil depends on spacing and planting arrangement. Proper planting arrangement is an important factor affecting yield attributes and nutrient content of maize which ultimately influence grain yield. BARI (1989) recommended two planting arrangements for maize-one plant per hill 25 cm apart and two plants per hill BO cm apart- both in rows 75 cm apart. But it seems there may be intra-pleat competition when two plants per hill are planted. Plant spacing and number of plants per hill were found to have significant effect on grain yield (Shah *et al.,* 1989). These factors may also affect nutrient uptake. So, in order to increase the efficiency of nutrient uptake in maize a study on planting arrangement for different varieties seems worthwhile. With the above background, the experiment was designed to study the effect of variety and planting arrangement on nutrition and nutrient uptake in maize.

Materials and Methods

The experiment was conducted at Soriatola silt loam, an inoeptisol, at Bangladesh Agricultural University Farm, Mymensingh in the rabi season (November-April). The soil had pH of 6.75 and contained 0.11% total N, 16 ppm available P, 0.27 meg/100 g soil exchangeable K, 14 ppm available S and 3 ppm evadable Zn.

The experiment was conducted in split-design with three replications by placing variety in the main plot and planting arrangement in the sub plot. The study included four maize varieties, namely, Barnali, Khoibhutta, Mohor and Shuvra and two planting arrangements which were one plant per hill 25 cm apart (P_1) and two plants per hill 50 cm apart (P_2) both in a constant row spacing of 75 cm.

Land preparation started in early November and fertilizers were applied at the rates of 125 Kg N, 65 kg P_7O_5, 51 kg K_2O, 22 kg S and 5.5 kg Zn per hectare as per BARI (1989) recommendations. Seeding was done on 17 November. The crop was harvested at maturity in April. The size of unit plot was 7 m x 4.5 m of which 5 m x 3 m was used for sampling, final harvest and collection of data.

Grain and stalk samples were collected at harvest, oven dried at 65°C overnight, ground in a grinding machine, and approximately 10 g sampies, each for grain and stalk, were used for the determination N, P, K, S and Zn contents in the grain and stalk. The total nitrogen content was determined by micro-kjeldahl method. Materials for P, K, S and Zn determinations were digested in nitric and perchloric acids. From the digest, P was determined by developing colour by stannous chloride reduction of phosphomolybdate complex and measuring the colour calorimetrically and S was determined turbidimetrically. Potassium and Zn concentrations were determined from the digest by atomic absorption

spectrophotometer. Nutrient uptake was calculated from nutrient content multiplied by respective yield.

Collected data were analyzed statistically and the significance of mean differences were adjudged by the Least Significant Difference (LSD) test.

Results and Discussions

The effects of variety on nutrient content in grain and stalk have been presented in Table 1. Results showed that N, P, K and Zn content in grain and N, P, S and Zn content in stalk differed significantly among the varieties. Nitrogen content in grain was the highest in Khoibhutta (1.46%) followed by Mohor (1.40%). However, N content in stalk was the highest in Shuvra 10.45%) which was identifically followed by Khoibhutta, Barnali and Mohor. Phosphorus content in grain was the highest in Mohor (0.40%) whereas, in case of stalk, P content was the highest tin Khoibhutta (0.12%) which was identically followed by Mohor (0.11%), Shuvra (0.10%) and Somali (0.08%). Grain K content was the highest in Shuvra (0.30%) which was identically followed by Mohor (0.29%) and Barnali (0.28%). 5 content in stalk was the highest in Shuvra and Barnali (0.13%). Grain Zn was the highest in Barnali (76.45 ppm) in the lowest in Khoibhutta (52.62 ppm).

Effects of planting arrangement on nutrient content in grain and stalk have been shown in Table 2.

All the grain nutrient content except Zn were similar in P_1 (one plant per hill 25 cm apart) and P_2 (two plants per hill 50 cm apart). However, grain Zn content was higher in P_2. Stalk N, P, S content were higher in P_1 than P_2.

Effects of variety on the yield and nutrient uptake were shown in Table 3, 4.

Results showed that N, P and Zn uptake by grain and stalk and total N, P, K, S and Zn uptake were statistically significant. However, K and S uptake by grain were statistically significant but by stalk were similar (Table 3 and 4). Nitrogen uptake by grain was the highest in Mohor (81.76 kg ha^{-1}) which was identically followed by Shuvra (30.28 kg ha^{-1}) and this was identically followed by Mohor (29.63 kg ha^{-1}) and Barnali (25.90 kg ha^{-1}). In *case* of total uptake similar result was observed. Similar effect of variety on N uptake was also reported by McCullough *et al.* (1994). The highest total P uptake was in the variety Mohor (30.66 kg ha^{-1}). However, the highest P uptake by grain was in Shuvra (19.52 kg ha^{-1}) which was identically followed by Barnali (18.75 kg ha^{-1}). Besides, the highest P uptake by stalk was in Mohor (7.90 kg ha^{-1}) and it was identically followed by Shuvra (6.75 kg ha^{-1}). The highest K uptake by grain was found in Shuvra which was 18.75 kg ha^{-1}, This was identically followed by Mohor (16.95 kg ha^{-1}). The highest total K uptake was found in Mohor (93.40 kg ha^{-1}). Similar effect of variety on P and K uptake was also reported by Singh *et al.* (1991). Sulphur uptake by grain ranged from 8.08 to 10.25 kg ha^{-1}. Total S uptake was the highest in Shuvra (19.31 kg ha^{-1}) which we identically followed by Mohor and Barnali (17.40 and 17.34 kg ha^{-1} respectively). Zinc uptake was the highest by stalk in Shuvra and Mohor (0.29 kg ha^{-1}) and by grain in Barnali (0.42 kg ha^{-1}). However, total uptake was the highest in Shuvra (0.64 kg ha^{-1}).

Table 1: Effect of variety on nutrient content of grain and stalk of maize

Variety	N (%)		F (%)		K (%)		S (%)		Zn (ppm)	
	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk
Barnali	1.36	0.43	0.34	0.08	0.28	1.1	0.17	0.13	76.45	31.8
Khoibhutta	1.46	0.44	0.35	0.12	0.23	1.17	0.18	0.12	52.62	25.05
Mohor	1.40	0.41	0.40	0.11	0.29	1.06	0.16	0.10	66.58	39.50
Shuvra	1.32	0.45	0.32	0.1	0.30	1.02	0.17	0.13	56.36	42.55
LSD (0.05)	0.04	0.03	0.03	0.03	0.04	NS	NS	0.02	4.69	3.06
CV(%)	5.90	7.40	10.70	11.20	10.00	8.30	14.30	11.90	3.50	9.20

NS = Non significant

Table 2: Effect of planting arrangement on nutrient content of grain and stalk of maize

Planting arrangement	N (%)		P (%)		K (%)		S (%)		Zn (ppm)	
	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk
One plant/hill 25cm apart	1.40	4.46	0.36	0.11	0.28	1 08	0.17	0.13	58.43	36.05
Two plants/hill 50cm apart	1.36	0.41	0.34	0.09	0.28	1.10	0.17	0.11	62.55	33.90
LSD (0.05)	NS	0.03	NS	0.03	NS	NS	NS	0.03	2.00	NS
CV (%)	5.90	4.70	10.7	11.2	10.0	8.3	14.3	11.9	3.5	9.2

NS = Non significant

Table 3: Effect of variety on grain, stalk and nutrient in uptake by grain and stalk of maize

Variety	Yield (kg ha^{-1})		N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})		S (kg ha^{-1})		Zn (kg ha^{-1})	
	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk
Barnali	5.59	5.97	76.18	25.90	18.75	4.49	15.62	64.24	9.51	7.83	0.42	0.19
Khoibhutta	4.64	4,98	67.56	21.69	16.17	6.04	10.62	58.22	8.02	6.01	0.24	0.13
Mohor	5.84	7,21	81.76	29.63	22.77	7.9	16.95	78.45	9.92	7.48	0.33	0.29
Shuvra	6.20	6.71	81.53	30.28	19.52	6.75	10.95	68.44	10.25	9.01	0.35	0.29
LSD (0.05)	0.36	1.20	5.42	5.58	2.37	1.6	2.09	NS	1.32	NS	0.03	0.04
CV(%)	3.20	3.40	3.90	7.80	7.30	12.20	9.30	8.90	8.70	13.70	5.40	11.00

NS = Not significant

Table 4: Effect of varlet on total nutrient uptake of maize

Variety	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})	Zn (kg ha^{-1})
Bamail	102.1	23.23	79.86	17.34	0.61
Khoibhutta	89.2	22.21	68.84	14.09	0.37
Mellor	111.4	30.66	93.4	17.4	0.61
Shuvra	110.5	26.27	87.45	19.31	0.64
LSD (0.05)	10.0	3.48	14.49	3.38	0.04
CV (%)	4.0	6.9	7.5	8.8	5.9

NS = Not significant

Table 5: Effect of planting arrangement on gain, stalk yield and nutrient uptake by grain and stalk of maize

Planting arrangement	Yield (kg ha^{-1})		N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})		S (kg ha^{-1})		Zn (kg ha^{-1})	
	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk
One plant/hill 25 cm apart	5.72	6.45	80.16	29.29	20.38	7.16	16.06	68.38	9.61	87.16	0.33	0.24
Two plants/hill 50 cm apart	5.41	5.98	73.35	24.46	18.23	5.43	15.01	65.30	9.27	6.69	0.34	0.21
LSD (0.05)	0.17	0.20	2.84	1.98	1.32	0.72	NS	NS	NS	0.98	NS	0.03
CV (%)	3.20	3.40	3.90	7.80	7.30	12.2	9.30	8.90	8.70	13.7	5.4	11.0

NS = Not significant

Table 6: Effect of planting arrangement on total nutrient uptake

Variety	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})	Zn (kg ha^{-1})
One plant/hill 25cm apart	108.6	27.53	84.47	18.11	0.59
Two plants/hill 50 cm apart	98.0	23.66	80.30	15.96	0.55
LSD (0.05)	3.9	0.67	NS	1.41	NS
CV (%)	4.0	6.90	7.5	8.8	5.90

NS = Non significant

The highest grain yield (6.20 t ha^{-1}) came from the variety Shuvra followed by Mohor (5.84 t ha^{-1}) and Barnali (5.59 t ha^{-1}) and the lowest by Khoibhutta. However, Mohor produced the highest stalk yield (7.21 t ha^{-1}) which was identically followed by Shuvra (6.71 t ha^{-1}). Table 3 and 4 showed that the higher nutrient uptake by Shuvra and Mohor were associated with their higher grain and stalk yield. Effect of planting arrangement on the yield and nutrient uptake were presented in Table 5 and 6. Effects of planting arrangement on N and P uptake by grain, N, P, S and Zn uptake by stalk and total N, P and S uptake were statistically significant. Results indicated that planting arrangement had influenced on nutrient uptake. One plant per hill 25 cm apart (P_1) caused more uptake than two plants per hill 50 cm apart (P_2). Besides, P_1 produced higher grain and stalk yield (5.72 t ha^{-1} and 6.45 t ha^{-1} respectively) than P_2 (5.41 t ha^{-1} and 5.88 t ha^{-1} respectively).

This study showed that the varieties Shuvra and Mohor and one plant per hill 25 cm apart had higher nutrient uptake efficiency that resultant higher grain and stalk yield.

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