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Wasim Khan
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P, India

Vikram Singh
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P, India

Abhishek Sagar
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P, India

Sachchida Nand Singh
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P, India

Correspondence
Wasim Khan
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P, India

Response of phosphorus application on growth and yield attributes of sweet corn (*Zea mays* L. *saccharata*) varieties

Wasim Khan, Vikram Singh, Abhishek Sagar and Sachchida Nand Singh

Abstract
A field experiment was conducted during *kharif* 2016 at Crop Research Farm, Department of Agronomy, SHUATS, Allahabad, (U.P.). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.7), low in organic carbon (0.35%), available N (230 kg ha^{-1}), available P (20 kg ha^{-1}) and available K (189 kg ha^{-1}). The treatment consisted of 5 levels of Phosphorus *viz.* P_1 (40 kg P_2O_5 ha^{-1}), P_2 (50 kg P_2O_5 ha^{-1}), P_3 (60 kg P_2O_5 ha^{-1}) P_4 (70 kg P_2O_5 ha^{-1}) and P_5 (80 kg P_2O_5 ha^{-1}) and 2 sweet corn varieties *viz*. V_1 (Sweet Glory) and V_2 (Sweety). There were 10 treatments each replicated thrice. The experiment was laid out in Randomized Block Design. The result showed that growth attributes *viz.*, plant height (213.00 cm) at 80 DAS, number of green leaves $plant^{-1}$ (5.87) at 40 DAS, Dry weight (200.77 g) at 80 DAS and CGR (32.52 g m^{-2} day^{-1}) at 80 DAS and yield attributes *viz.*, cob weight with husk (325.27 g), cob weight without husk (250.30 g), Average grains row^{-1} (35.30), Average grain rows cob^{-1} (16.00), Average grains cob^{-1} (564.80) and 100-Grain Weight (23.93 g) were recorded maximum in 'sweety' variety in treatment T_8 (Sweety + 60 kg P_2O_5 ha^{-1}). These parameters were significantly influenced by application of 60 kg P_2O_5 ha^{-1}as DAP. However, number of green leaves $plant^{-1}$ at 80 DAS, RGR, Cob length and number of cobs $plant^{-1}$ were found to be non- significant.

Keywords: Sweet corn, Varieties, phosphorus levels.

Introduction
Maize (*Zea mays*) is a C_4 plant and has high yielding potential. Besides human food and animal feed, this crop has its significance as a source of large number of industrial products like starch and oil. Maize grain contains about 10 % protein, 4 % oil, 70 % carbohydrate, 2.3 % crude fibre, 10.4 % albuminoids, and 1-4 % ash. It also contains vitamin A, nicotine acid and riboflavin, vitamin E. Maize is important crop in the world grown in more than 150 countries having 600 million ha area with 600 million ton of production. The major maize producing countries are USA, China, Brazil, Mexico, France and India. USA has the largest area and production in the world. Italy having highest productivity in the world 9600 kg ha^{-1} followed by France with 8800 kg ha^{-1}. India stand is 5 position in total area, fourth in total production and third in yield per hectare after USA China, Brazil and Mexico but with regards to production its rank eleventh. It is a widely grown cereal and is categorized as primary staple food in many developing countries. India contributes merely about 2.5 percent in world maize production. It is third most important cereal crop after rice and wheat and is being grown throughout the year but mainly as *kharif* crop. At present maize is being grown in most of the states of the country with annual grain production of 24.53 million tonnes and productivity 2583 kg ha^{-1}. The maize is cultivated throughout the year in all states of the country for various purposes including grain, fodder, green cobs, sweet corn, baby corn, popcorn in peri-urban areas. Special corn *viz*., sweet corn, popcorn, baby corn, high-oil corn *etc*. assume tremendous market potential not only in the international market but also in India. These corns with their high market value are perfectly suitable to *peri*-urban agriculture. Thus they promise higher income to maize growers. Out of the various special corn, sweet corn (*Zea mays* L. *saccharata*) has a big market potential. It is a hybridized variety of maize specifically bred to increase the sugar content. Sustainability of scientific sweet corn cultivation practices must be ensured to attain the goal of agricultural sustainability. Its consumption at immature stage as roasted and boiled ears is a popular practice as the kernels are sweet (12-20% sugar). After harvest green cobs, the plant of sweet corn are used green fresh or dry fodder and now a day's its cultivation is the first choice of the farmers. Maize is an exhaustive crop and requires high quantities of nitrogen and phosphorus. Low soil fertility is one of the bottlenecks to sustain agricultural production and productivity in India.

Judicious use of fertilizers play an important role to boost up the productivity of maize, they alone can contribute 40-60 percent of the crop yield (Dayanand, 1998) [1].

Among nutrient elements, phosphorus plays a vital role besides nitrogen in plant nutrient that influences vigour of plant, root growth and improves the quality of crop yield. Phosphorus is an essential factor for cell division because it is a constituent element of nucleoproteins which are involved in the cell reproduction processes. It is also a component of a chemical essential to the reactions of carbohydrate synthesis and degradation. It is important for seed and fruit formation and crop maturation. Phosphorus hastens the ripening of fruits thus counteracting the effect of excess nitrogen application to the soil. It helps to strengthen the skeletal structure of the plant thereby preventing lodging. It also affects the quality of the grains and it may increase the plant resistance to diseases.

Since the phosphate availability is usually low in the soils, the plants have developed special adaptations to acquire the same with the help of multiple high affinity transporters (Raghothama, 1999) [5]. The needs of a sweet corn crop for supplemental nutrient can vary greatly among field's seasons and crop growing conditions. Hence, there is need to evaluate sweet corn varieties under optimum phosphorus fertilization under prevailing agro climatic conditions.

Materials and Methods

The experiment was conducted during the *kharif* season of 2016 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Allahabad. The Crop Research Farm is situated at 25^0 57' N latitude, 87^0 19' E longitude and at an altitude of 98 m above mean sea level. The soil of experimental plot was sandy loam in texture, neutral in soil reaction (pH 7.5), low in organic carbon (0.35%), available N (230 kg ha^{-1}), available P (20 kg ha^{-1}) and available K (189 kg ha^{-1}). The treatments comprised of 5 levels of Phosphorus *viz.* P_1 (40 kg P_2O_5 ha^{-1}), P_2 (50 kg P_2O_5 ha^{-1}), P_3 (60 kg P_2O_5 ha^{-1}) P_4 (70 kg P_2O_5 ha^{-1}) and P_5 (80 kg P_2O_5 ha^{-1}) and 2 sweet corn varieties *viz.* V_1 (Sweet Glory) and V_2 (Sweety). There were 10 treatments each replicated thrice. The experiment was laid out in Randomized Block Design. Pre-harvest observation *viz.* Plant height, green leaves $plant^{-1}$, dry weight, Crop Growth Rate and Relative Growth Rate were recorded. Post- harvest observation *viz.* Cobs $plant^{-1}$, Cob length, Cob weight With husk, Cob weight Without husk, Grains row^{-1}, Grain rows cob^{-1}, Grains cob^{-1} and 100-Grain weight were recorded to find out the best treatment combination.

Results and Discussion

Performance of Varieties

Among both varieties 'Sweety' significantly recorded maximum plant height at 80 DAS, Green leaves $plant^{-1}$ at 40 DAS, Dry weight at 80 DAS and CGR at 80 DAS whereas, cob weight with husk, cob weight without husk, Average grains row^{-1}, Average grain rows cob^{-1}, Average grains cob^{-1} and 100-Grain Weight as compared to 'Sweet Glory'. However, Green leaves $plant^{-1}$ at 80 DAS, RGR, Cob length and number of cobs $plant^{-1}$ were found to be non- significant (Table 1). The maximum plant height (213.00 cm) at 80 DAS, Green leaves $plant^{-1}$ (5.87) at 40 DAS, Dry weight (200.77 g) at 80 DAS and CGR (32.52 g m^{-2} day^{-1}) at 80 DAS (Table 2) whereas, cob weight with husk (325.27 g), cob weight without husk (250.30 g), Average grains row^{-1} (35.30), Average grain rows cob^{-1} (16.00), Average grains cob^{-1} (564.80) and 100-Grain Weight (23.93 g) were recorded in 'Sweety' variety as compared to 'Sweet glory' variety (Table 3). Under present investigation the better performance of 'Sweety' seems to be on account of higher uptake of nitrogen and phosphorus from soil and its reallocation in grain and plant. The higher availability of nitrogen and phosphorus seems to have promoted development of morphological structure by virtue of multiplication of cell division which is well reflected through increased crop growth rate (Kumar, 2008) [2].

Table 1: Effect of different Phosphorus levels on Green leaves $plant^{-1}$, RGR, cobs $plant^{-1}$ and Cob length of Sweet corn varieties

Treatments		Green leaves $plant^{-1}$ at 80 DAS	RGR at 80 DAS	Cobs $plant^{-1}$	Cob length
T_1	Sweet Glory + 40 kg P_2O_5 ha^{-1}	8.53	0.04	1.00	16.00
T_2	Sweet Glory + 50 kg P_2O_5 ha^{-1}	8.60	0.04	1.07	17.50
T_3	Sweet Glory + 60 kg P_2O_5 ha^{-1}	8.67	0.03	1.20	18.00
T_4	Sweet Glory + 70 kg P_2O_5 ha^{-1}	8.73	0.03	1.20	18.03
T_5	Sweet Glory + 80 kg P_2O_5 ha^{-1}	8.80	0.03	1.20	18.07
T_6	Sweety + 40 kg P_2O_5 ha^{-1}	8.60	0.04	1.00	16.20
T_7	Sweety + 50 kg P_2O_5 ha^{-1}	8.67	0.03	1.00	17.70
T_8	Sweety + 60 kg P_2O_5 ha^{-1}	8.73	0.03	1.20	18.20
T_9	Sweety + 70 kg P_2O_5 ha^{-1}	8.80	0.03	1.20	18.23
T_{10}	Sweety + 80 kg P_2O_5 ha^{-1}	8.87	0.03	1.20	18.27
SE (d)±		0.201	0.002	0.128	1.173
C. D. (P = 0.05)		NS	NS	NS	NS

Table 2: Effect of different Phosphorus levels on Plant height, Green leaves $plant^{-1}$ at 40 DAS, Dry weight and CGR of Sweet corn varieties

Treatments		Plant height At 80 DAS	Green leaves $plant^{-1}$ at 40 DAS	Dry weight At 80 DAS	CGR At 80 DAS
T_1	Sweet Glory + 40 kg P_2O_5 ha^{-1}	191.60	5.33	157.75	27.45
T_2	Sweet Glory + 50 kg P_2O_5 ha^{-1}	202.27	5.47	182.21	30.44
T_3	Sweet Glory + 60 kg P_2O_5 ha^{-1}	212.47	5.80	197.02	32.32
T_4	Sweet Glory + 70 kg P_2O_5 ha^{-1}	212.52	5.87	197.05	32.33
T_5	Sweet Glory + 80 kg P_2O_5 ha^{-1}	212.53	5.93	197.06	32.33
T_6	Sweety + 40 kg P_2O_5 ha^{-1}	194.87	5.67	162.98	27.57
T_7	Sweety + 50 kg P_2O_5 ha^{-1}	203.77	5.80	185.02	29.70
T_8	Sweety + 60 kg P_2O_5 ha^{-1}	213.00	5.87	200.77	32.52
T_9	Sweety + 70 kg P_2O_5 ha^{-1}	213.13	5.90	200.80	32.53
T_{10}	Sweety + 80 kg P_2O_5 ha^{-1}	213.17	5.93	200.82	32.53
SE (d) ±		5.356	0.182	2.024	1.022
C. D. (P = 0.05)		11.055	0.375	4.178	2.109

Table 3: Effect of different Phosphorus levels on Cob weight with husk, Cob weight without husk, Average grains row^{-1}, Average grain rows cob^{-1}, Average grains cob^{-1} and 100- Grain Weight of Sweet corn varieties

Treatments	Cob weight with husk (g)		Cob weight without husk (g)	Grains row^{-1} (Avg.)	Grain rows cob^{-1} (Avg.)	Grains cob^{-1} (Avg.)	100- Grain Weight (g)
T_1	Sweet Glory + 40 kg P_2O_5 ha^{-1}	230.47	180.80	29.27	14.80	433.19	21.63
T_2	Sweet Glory + 50 kg P_2O_5 ha^{-1}	270.47	210.80	32.77	14.80	484.99	22.73
T_3	Sweet Glory + 60 kg P_2O_5 ha^{-1}	295.97	231.05	34.03	15.20	517.25	23.63
T_4	Sweet Glory + 70 kg P_2O_5 ha^{-1}	296.00	231.07	34.10	15.20	518.32	23.67
T_5	Sweet Glory + 80 kg P_2O_5 ha^{-1}	296.00	231.08	34.13	15.20	518.77	23.67
T_6	Sweety + 40 kg P_2O_5 ha^{-1}	280.00	200.00	29.67	15.20	450.98	21.90
T_7	Sweety + 50 kg P_2O_5 ha^{-1}	310.00	230.30	33.00	15.60	514.80	22.93
T_8	Sweety + 60 kg P_2O_5 ha^{-1}	325.27	250.30	35.30	16.00	564.80	23.93
T_9	Sweety + 70 kg P_2O_5 ha^{-1}	325.30	250.33	35.37	16.00	565.92	23.97
T_{10}	Sweety + 80 kg P_2O_5 ha^{-1}	325.33	250.35	35.40	16.00	566.40	24.00
SE (d) ±		15.913	9.400	1.408	0.360	22.600	0.623
C. D. (P = 0.05)		32.844	19.75	2.906	0.760	47.490	1.286

Effect of phosphorus levels

Growth attributes *viz.*, plant height, green leaves plant^{-1} at 40 DAS, Dry weight and CGR likewise, yield attributes *viz.*, cob weight with husk, cob weight without husk, Average grains row^{-1}, Average grain rows cob^{-1}, Average grains cob^{-1} and 100-Grain Weight increased significantly in treatment T_8 with the application of 60 kg P_2O_5 ha^{-1}(Table 2 & Table 3). However, green leaves plant^{-1} at 80 DAS, RGR, Cob length and number of cobs plant^{-1} were found to be non-significant with the application 60 kg P_2O_5 ha^{-1} (Table 1). The maximum plant height (213.00 cm) at 80 DAS, green leaves plant^{-1} (5.87) at 40 DAS, Dry weight (200.77 g) at 80 DAS, cob weight without husk (250.30 g), Average grains row^{-1} (35.30) and 100-Grain Weight (23.93 g) were recorded in treatment T_8 with the application of 60 kg P_2O_5 ha^{-1} followed by treatment T_5 and it was found to be at par to treatment T_8 (Table 2 & Table 3) whereas, CGR (32.52 g m^{-2} day^{-1}) at 80 DAS and Average grains cob^{-1} (564.80) was recorded in treatment T_8 with the application of 60 kg P_2O_5 ha^{-1} followed by treatment T_5 and T_4 it was found to be at par to treatment T_8 (Table 2) and cob weight with husk (325.27 g), Average grain rows cob^{-1} (16.00), were recorded in treatment T_8 with the application of 60 kg P_2O_5 ha^{-1} followed by treatment T_7 and it was found to be at par to treatment T_8 (Table 3). Application of 120-60 kg N-P_2O_5 ha^{-1} might have increased interception, absorption and utilization of radiant energy which in turn increased photosynthesis and thereby plant height and finally accumulation of dry matter. The enhanced growth with nitrogen was reported by Massey and Gaur (2006) [4] and Khazaei *et al.* (2010) [3]. Significant improvement in overall growth of the crop by virtue of increased photosynthetic efficiency. Thus greater availability of photosynthates, metabolites and nutrients to develop reproductive structures seems to have resulted in increased productive plants, cob length and cob weight with these fertility levels. The present findings are within the close vicinity of those reported by Massey and Guar (2006) [4] and Khazaei *et al.* (2010) [3].

Conclusion

Based on the findings, of this experiment it can be concluded that 'Sweety' is the best and economically profitable variety as compared to 'Sweet Glory' variety. Application of 60 kg P_2O_5 ha^{-1} as DAP is profitable for farmers because it has significantly recorded higher growth attributes *viz.* Plant height, green leaves plant^{-1} at 40 DAS, Dry weight and Crop Growth Rate likewise, yield attributes *viz.*, Cob weight With husk, Cob weight Without husk, Grains row^{-1}, Grain rows cob^{-1}, Grains cob^{-1} and 100- Grain weight in sweet corn crop. Although the finding is based on one year further research is needed to conform the findings and its recommendation.

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