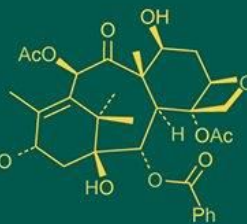
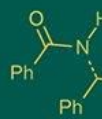
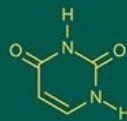
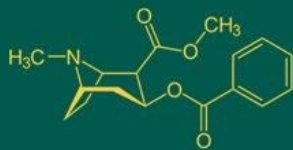


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Effect of spacing and silicon on growth and yield of maize (*Zea mays* L.)

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Abstract

A field experiment was conducted during *Kharif* season 2023 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj 211007 U.P. To determine "Effect of spacing and silicon on growth and yield of Maize (*Zea mays* L.)". The treatment consisted of three levels of spacing (50 × 50), (60 × 25), (45 × 45) respectively and three levels of silicon (0.5%, 1.0%, 1.5%). The experiment was laid out in a Randomized Block Design with 10 treatments and replicated thrice. The result revealed that [Spacing (60 × 25) cm² + Silicon 1.0%] (treatment 5) recorded significantly higher plant height (191.00 cm), higher plant dry weight (165.00 g), maximum number of cobs/plant (1.82), maximum number of grains/row (24.00), maximum number of rows/cob (12.94), higher test weight (22.50 g), higher seed yield (5.63 t/ha) and higher stover yield (9.60 t/ha). Maximum gross return (147750.00 INR/ha), net return (102985.00 INR/ha) and B:C ratio (2.30) was recorded in (treatment 5) [Spacing (60 × 25) cm² + Silicon 1.0%] was found to be productive as well as economically feasible.

Keywords: Maize, spacing, silicon, growth, yield and economics

Introduction

Maize is the world's most widely cultivated food crop providing ample food calories and protein for more than one thousand million human beings in the world. It is known as the "Queen of Cereals" because it has the highest genetic yield potential among the cereals. The term corn refers as "to sustain life" that provides nutrients for human and animals worldwide. It is cultivated throughout the year in all the seasons and grown around the globe. Because of its 72% starch, 10% protein, 8.5% fiber, 4.8% oil, 3.0% sugar, and 1.7% ash content, maize has a high nutritional value. It yields more than other cereals such as wheat, rice, and so on. Maize starch that has been hydrolyzed and enzyme-treated to produce syrups, especially high-fructose corn syrup, a sweetener, can be fermented and distilled to produce grain alcohol. Maize is one of the important food grains, which ranks fifth in area and production after rice and wheat and is grown in almost all parts of the country but it is staple food of hilly and sub mountain area of north India.

Globally, maize covers an area of 200.53 million hectares with the production of 1,275.94 million tons with the productivity of 6.36 tons/ha (USDA, 2024) ^[25]. In India, Maize is grown over an area of about 10.04 million hectares with a production of 33.62 million tons and productivity of 3.3 t/ha. Total area coverage under maize in Uttar Pradesh is 2.61 million hectares with a production of 6.09 million tons and the productivity 2.3 t/ha (GOI, 2022) ^[7].

Agronomists are currently studying plant populations to find ways to increase yield per unit area. Adjustment of proper plant spacing in the maize field is important to ensure maximum utilization of solar energy by the crop and reduce evaporation of soil moisture. Planting is undesirable because it encourages inter-plant competition for resources such as nutrients, sunlight, soil moisture etc. thus, appropriate plant spacing have to be ensured with a view to maximizing maize yield. Similar result was also reported by (Hasan *et al.*, 2018) ^[87].

Silicon enhances disease resistance in plants, imparts turgidity to the cell walls and has a purgative role in mitigating the metal toxicities (Bhat *et al.*, 2019) ^[2]. Transpiration from leaves of some plants is considerably reduced by the application of Si (Wang *et al.*, 2021) ^[26]. Several studies revealed that Si application significantly increased the water-use efficiency (WUE) of maize (*Zea mays* L.) plants. However, information on concentration of silicate

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fertilizers and their effect on growth and yield of maize is very limited. Keeping in view of the above fact, the experiment was conducted to find out “Effect of Spacing and Silicon on growth and yield of Maize”.

Also, proper spacing is crucial for maize production as it significantly impacts plant growth, yield, and overall crop health. Spacing is generally depends upon the expected growth of a particular crop in a given set of agro-climate, which determines the plant density. The space allowed to individual plant is one of the determining factors controlling their development and yield. Close spacing leads to overcrowding and more plant competition for growth factors, whereas wider spacing reduce the plant population enhance the vegetative growth and provide favorable condition to weed growth thereby decreasing the total yield (Johannes *et al.*, 2021) ^[13]. The cumulative yield per unit area is higher under high plant population but the yield per plant is low. The optimum plant spacing provides better conditions for plant growth which results in timely commencement of reproductive phase and formation of sink (Nangial *et al.*, 2020) ^[19]. The establishment of an optimum plant population per unit area of land is the contributory factor, which determines the yield of maize. Keeping in view of the above fact, the experiment was conducted to find out “Effect of Spacing and Silicon on growth and yield of Maize”.

Materials and Methods

The experiment was conducted during *Kharif season* 2023 at Crop Research Farm, Department of Agronomy, (SHUATS), Naini, Prayagraj 211007, UP. The soil of the experimental field was sandy loam in texture, with soil (pH 6.9), low level of organic carbon (0.62%), available N (225 Kg/ha), P (38.2 kg/ha), K (240.7 kg/ha) and silicon (1.0% ml/l). The treatment consists of three levels of Spacing along with the combination of three levels of Silicon. The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T₁ Spacing (50 × 50) cm² + Silicon 0.5%, T₂ Spacing (50 × 50) cm² + Silicon 1.0%, T₃ Spacing (50 × 50) cm² + Silicon 1.5%, T₄ Spacing (60 × 25) cm² + Silicon 0.5%, T₅ Spacing (60 × 25) cm² + Silicon 1.0%, T₆ Spacing (60 × 25) cm² + Silicon 1.5%, T₇ Spacing (45 × 45) cm² + Silicon 0.5%, T₈ Spacing (45 × 45) cm² + Silicon 0.5%, T₉ Spacing (45 × 45) cm² + Silicon 1.5%, T₁₀ Spacing (60 × 25) cm². Data recorded on different aspects of crop, *viz.*, plant height, dry weight, crop growth rate, relative growth rate and number of cobs/plants, number of grains/row, number of row/cob, test weight (g), seed yield (t/ha), stover yield (t/ha), harvest index (%) were subjected to statistically analyzed by analysis of variance method as described by Gomez and Gomez, (1976). The cost of cultivation for each treatment was worked out taking in prevailing market price of inputs. Similarly, gross returns were calculated based on prevailing market price of the produce. The net returns INR/ha was calculated by deducting the cost of cultivation from the gross return's INR/ha basis. The B:C ratio was calculated by Net Return INR/ha dividing by Cost of cultivation.

Results and Discussion

A. Growth Parameter

Plant Height (cm): At 80 DAS, significant and higher plant height (191.00 cm) was observed in the treatment 5 [Spacing (60 × 25) cm² + Silicon at 1.0%]. However,

treatment 3 [Spacing (50 × 50) cm² + Silicon 1.5%], treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%], treatment 6 [Spacing (60 × 25) cm² + Silicon 1.5%], treatment 7 [Spacing (45 × 45) cm² + Silicon 0.5%], treatment 8 [Spacing (45 × 45) cm² + Silicon 1.0%] and treatment 9 [Spacing (45 × 45) cm² + Silicon 1.5%] were found to be statistically at par with treatment 5 [Spacing (60 × 25) cm² + Silicon at 1.0%]. Significant and higher plant height was observed with [Spacing (60 × 25) cm²] may be due to plant resulted increased plant height as the plant density increased, where this might be attribute to significant effect of row spacing on plant height, similar result was also reported by Azam *et al.* (2017) ^[1]. Further, significant and higher plant height was observed with application silicon at 1.0% may be due to silicon increases plant resistance to lodging, enhancing photosynthesis, increases plant tolerance to strong sunlight or shading, decreases oxidative damage in stressful plants, similar result was also reported by Hassan *et al.* (2019) ^[9].

Plant Dry Weight (g): At 80 DAS, significantly higher plant dry weight (165.00 g) was observed in treatment 5 [60 × 25 cm² spacing + 1.0% Silicon]. However, treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%] was found to be statistically at par with the treatment 5 [60 × 25 cm² spacing + 1.0% Silicon]. Significant and higher plant dry weight was observed with Spacing (60 × 25) cm² may be due to increases in the plant population between the row spacing which resulted may have higher plant dry weight increased the vegetative growth of the plant. Similar result was also reported by Singh *et al.* (2022) ^[21]. Further, significant and higher plant dry weight was observed with application of silicon at 1.0% may be due to the different levels of silicon, the combination of soil and foliar application recorded increase highest dry matter yield compared to individual application of soil and foliar, application of silicon was found to be lesser effect compared to soil application similar result was also reported by Jawahar *et al.* (2020) ^[11].

Crop Growth Rate (g/m²/day): During 40-60 DAS intervals, treatment 5 [60 × 25) cm² + Silicon 1.0%] recorded highest crop growth rate (32.33 g/m²/day). However, treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%], treatment 6 [Spacing (60 × 25) cm² + Silicon 1.5%] was found to be statistically at par with the treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. Significant and higher crop growth rate was observed with Spacing (60 × 25) cm² may be due to the increase in crop growth rate is attributed to the plants accumulating more dry matter and increasing the row spacing between the plants. It began to fall after DAS because, while dry matter accumulation increased after the vegetative stage, the rate of accumulation was not as high as it was during the vegetative development stage, similar result was also reported by Jawahar *et al.* (2020) ^[11]. Further, significant and higher crop growth rate was observed with application of silicon at 1.0% may be due to, the plant growth rate (CGR) increased significantly with each increase in uptake depends on the concentration of silicon in the soil solution, pH and soil moisture content, two possible mechanisms (active and passive) were proposed for the uptake of silicon by plants, similar result was also reported by Purbajanti *et al.* (2022) ^[22].

Relative Growth Rate (g/g/day): At 40-60 DAS intervals, higher relative growth rate was recorded (0.1017 g/g/day) in treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%]. through there was no significant difference among all the treatments.

B. Yield Parameter

Number of cobs/plants: Treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%] recorded significant and maximum number of cobs/plant (1.82). However, treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%], treatment 6 [Spacing (60 × 25) cm² + Silicon 1.5%] was found to be statistically at par with treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. Significant and maximum number of cobs/plants was observed with spacing (60×25 cm) may be due to the cob length increased with each increment in spacing. Similar result was also reported by Gaire *et al.* (2020) [16]. Further, significant and maximum number of cobs/plants was observed with application silicon at 1.0% may be due to silicon accumulation in plant parts which reduce its lodging and enhanced resistance against biotic and abiotic stress, ultimately resulted maximum number of cobs/plants. Similar result was also reported by Prajapat *et al.* (2021) [20].

Number of grains/rows: Significantly and maximum number of grains/row (24.00) was recorded in the treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. However, treatment 2 [Spacing (50 × 50) cm² + Silicon 1.0%], treatment 3 [Spacing (50 × 50) cm² + Silicon 1.5%], treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%], treatment 6 [Spacing (60 × 25) cm² + Silicon 1.5%] treatment 8 [Spacing (45 × 45) cm² + Silicon 1.0%] and treatment 9 [Spacing (45 × 45) cm² + Silicon 1.5%] were found to be statistically at par with the treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. Significant and maximum number of grain/rows was observed with spacing (60 × 25) cm² might be due to the adequate plant spacing i.e. number of plants/unit area or plant density is also one of the main factors which ultimately lead to increase in cob yield or grain yield/unit area. Similar result was also reported by Manan *et al.* (2016) [18]. Further, significant and maximum number of grain/rows was observed with application silicon at 1.0% may be due to enhanced photosynthetic activity, density of grain by improving the translocation and accumulation of carbohydrates and increase in number of filled grains which influenced the biomass of grains resulted maximum number of grain/rows. Similar result was also reported by Prajapat *et al.* (2021) [20].

Number of rows/cobs: Treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%] recorded significant and maximum number of rows/cob (12.93). However, treatment 1 [Spacing (50 × 50) cm² + Silicon 0.5%], treatment 2 [Spacing (50 × 50) cm² + Silicon 1.0%], treatment 3 [Spacing (50 × 50) cm² + Silicon 1.5%], treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%], treatment 6 [Spacing (60 × 25) cm² + Silicon 1.5%] and treatment 7 [Spacing (45 × 45) cm² + Silicon 0.5%] were found to be statistically at par with the treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. Significant and maximum of rows/cob was observed with Spacing (60 × 25) cm² might be due to, the plant spacing beside the absorption of water and nutrient, the sunlight absorption may have affected the growth and yield of plant, good appropriate planting space improves soil fertility, soil tillage, fertilization, resulted increased the number of row/cobs.

Similar result was also reported by Dwipa *et al.* (2020) [14]. Further, significant and maximum number of rows/cobs was observed with application silicon at 1.0% may be due to silicon resulted in carbohydrates synthesis from photosynthetic activity for longer period might have resulted in efficient translocation of food material into the sink (grain) thereby increased number of row/cobs. Similar result was also reported by Kumar *et al.* (2023) [17].

Test weight (g): Significant and higher test weight (22.50 g) was observed treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. However, treatment 1 [Spacing (50 × 50) cm² + Silicon 0.5%], treatment 2 [Spacing (50 × 50) cm² + Silicon 1.0%], treatment 3 [Spacing (50 × 50) cm² + Silicon 1.5%], treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%], treatment 6 [Spacing (60 × 25) cm² + Silicon 1.5%], treatment 7 [Spacing (45 × 45) cm² + Silicon 0.5%] and treatment 8 [Spacing (45 × 45) cm² + Silicon 1.0%] were found to be statistically at par with the observed treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. Significant and higher test weight was observed with spacing (60 × 25) cm² may be due to the reason behind the higher hundred grain weight in row spacing could be as a result of high light capture and less competition for water outcome in greater accretion of photosynthesis. Similar result was also reported by Koirala *et al.* (2020) [15]. Further, significant and higher test weight was observed with application silicon at 1.0% might be due to, the increased hundred grain weight was registered under adequate irrigation condition, supplied at regular intervals, this might be due to increased plant growth characters up to significant level by increased availability of water and nutrients to plants under stress free moisture availability, Similar result was also reported by Kumar *et al.* (2018) [14].

Seed yield (t/ha): Significantly higher seed yield (5.62 t/ha) was recorded in the treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. However, treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%], treatment 6 [Spacing (60 × 25) cm² + Silicon 1.5%] was found to be statistically at par with the observed treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. Significant and higher seed yield was observed with spacing (60 × 25) cm² may be due to the wider distances between plant placement which allow for less competitive growth and development of more plants thus increasing seed yield, similar result was also reported by Chim *et al.* (2014) [3]. Further, significant and higher seed yield was observed with application silicon at 1.0% may be because of silicon during seedling growth, silicon mediated the photosynthetic rate, root activity and nitrate reductase activity which results in improvement in the maize yield, similar result was also reported by Kalyani *et al.* (2023) [17].

Stover yield (t/ha): Significant and higher stover yield (9.60 t/ha) was observed in treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. However, treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%] was found to be statistically at par with the observed treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. Significant and higher stover yield was observed with spacing (60 × 25) cm² may be due to the plant receive more sunlight by the canopy of plant and sufficient nutrient from the soil which results higher growth of plant and maximum stover yield. Similar results are obtained by Sally *et al.* (2019) [23]. Further, significant and higher stover

yield was observed with application silicon 1.0% may be due to the silicon application which resulted in more utilization of solar radiation, moisture and nutrients since silicon provides more erectness to plant for efficient utilization of solar radiation resulting in better stover yield, Similar results are obtained by Kumar *et al.* (2023) ^[17].

Harvest Index (%): Significant and higher harvest index (36.78%) was observed in the treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. However, treatment 4 [Spacing (60 × 25) cm² + Silicon 0.5%], treatment 6 [Spacing (60 × 25) cm² + Silicon 1.5%] and treatment 8 [Spacing (45 × 45) cm² + Silicon 1.0%] was found to be statistically at par with the observed treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%]. Significant and higher harvest index was observed with spacing (60 × 25) cm² may be due to the row spacing which tended to determine smaller variation of the harvest index according to plant density and maize yield. Similar results are obtained by Ion *et al.* (2015). Further, significant and higher harvest index was observed with application silicon at 1.0% might be due to, owing to deposition of Si at cellular parts such as cell wall, cell lumen and inter cellular space, and its deposition below and above cuticle layer that's why enhanced cell division and cell elongation than tissue parts more elongated and erect, cause erectness of leaves

and stem which enhanced towards plant height and also increase in chlorophyll content. Similar results are obtained by Prajapat *et al.* (2022) ^[21].

C. Economics

Gross return, net return and benefit cost ratio were influenced due to different treatments.

1. The results revealed that maximum gross return (147750.00 INR/ha), Maximum net returns (102985.00 INR/ha) and benefit cost ratio (2.30) were recorded in treatment 5 [Spacing (60 × 25) cm² + Silicon 1.0%] as compared to other treatments. Higher B:C ratio was observed with the Significant and maximum Benefit cost ratio was observed with spacing (60 × 25) cm² may be due to the study concluded that maize should be planted under spacing 60 × 25 cm to ensure maximum economic grain yield per production area by Koirala *et al.* (2020) ^[15]. Further, significant and maximum economic was observed with application silicon at 1.0% may be due to the silica which significantly enhance the growth, net return, B C ratio and post-harvest available P of soil. Among foliar application, spray of 1.0% active silica improved the growth and net return by Prajapat *et al.* (2022) ^[21].

Table 1: Effect of spacing and silicon on growth attributes of maize

S. No	Treatment Combination	Plant height (cm)	Dry weight (g)	CGR (g/m ² /day)	RGR (g/g/day)
		80 DAS	80 DAS	40-60 DAS	40-60 DAS
1	Spacing (50 × 50) cm ² + Silicon 0.5%	169.75	149.61	14.69	0.0962
2	Spacing (50 × 50) cm ² + Silicon 1.0%	172.28	147.33	15.40	0.0980
3	Spacing (50 × 50) cm ² + Silicon 1.5%	177.32	148.00	15.72	0.0962
4	Spacing (60 × 25) cm ² + Silicon 0.5%	187.35	155.00	31.10	0.1017
5	Spacing (60 × 25) cm ² + Silicon 1.0%	191.00	165.00	32.33	0.0965
6	Spacing (60 × 25) cm ² + Silicon 1.5%	187.93	151.47	31.61	0.0984
7	Spacing (45 × 45) cm ² + Silicon 0.5%	180.33	131.68	21.23	0.1009
8	Spacing (45 × 45) cm ² + Silicon 1.0%	183.68	134.68	21.77	0.0990
9	Spacing (45 × 45) cm ² + Silicon 1.5%	182.00	130.81	21.57	0.1003
10	Spacing (60 × 25) cm ²	162.68	149.33	24.05	0.0976
	F-test	S	S	S	NS
	S.E(m) (±)	5.26	4.42	0.95	0.0035
	CD (P=0.05)	15.64	13.15	2.8	-

Table 2: Effect of spacing and silicon on yield attributes and yield of maize

S. No	Treatment Combination	Number of cobs/plants	Number of grains/rows	Number of rows/cobs	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1	Spacing (50 × 50) cm ² + Silicon 0.5%	1.18	20.67	12.16	20.81	2.48	8.49	22.59
2	Spacing (50 × 50) cm ² + Silicon 1.0%	1.31	21.67	12.33	21.10	2.97	8.53	25.79
3	Spacing (50 × 50) cm ² + Silicon 1.5%	1.48	22.33	12.94	21.61	3.69	8.67	29.94
4	Spacing (60 × 25) cm ² + Silicon 0.5%	1.72	23.00	12.26	22.00	5.47	9.45	36.72
5	Spacing (60 × 25) cm ² + Silicon 1.0%	1.82	24.00	12.94	22.50	5.63	9.60	36.78
6	Spacing (60 × 25) cm ² + Silicon 1.5%	1.61	23.33	12.00	21.00	5.13	8.38	36.59
7	Spacing (45 × 45) cm ² + Silicon 0.5%	1.38	21.33	11.46	21.67	3.68	6.73	34.93
8	Spacing (45 × 45) cm ² + Silicon 1.0%	1.40	23.33	11.33	22.33	4.22	7.25	36.23
9	Spacing (45 × 45) cm ² + Silicon 1.5%	1.26	22.00	11.33	20.36	3.25	6.43	33.30
10	Spacing (60 × 25) cm ²	1.16	19.33	10.20	18.67	3.03	6.44	32.01
	F-test	S	S	S	S	S	S	S
	S.E(m) (±)	0.09	0.90	0.53	0.64	0.42	0.23	2.57
	CD (P=0.05)	0.26	2.66	1.56	1.89	1.26	0.70	7.66

Table 3: Effect of spacing and silicon on economics of various treatment combination of maize

S. No	Treatment Combination	Cost of cultivation (INR/ ha)	Gross Return (INR/ha)	Net Return (INR/ha)	Benefit Cost Ratio (B:C)
1	Spacing (50 × 50) cm ² + Silicon 0.5%	41645.00	78980.00	37335.00	0.90
2	Spacing (50 × 50) cm ² + Silicon 1.0%	41765.00	89790.00	48025.00	1.15
3	Spacing (50 × 50) cm ² + Silicon 1.5%	41885.00	109570.00	67685.00	1.62
4	Spacing (60 × 25) cm ² + Silicon 0.5%	44645.00	143480.00	98835.00	2.21
5	Spacing (60 × 25) cm ² + Silicon 1.0%	44765.00	147750.00	102985.00	2.30
6	Spacing (60 × 25) cm ² + Silicon 1.5%	44885.00	134680.00	89795.00	2.00
7	Spacing (45 × 45) cm ² + Silicon 0.5%	42545.00	110650.00	68105.00	1.60
8	Spacing (45 × 45) cm ² + Silicon 1.0%	42665.00	124700.00	82035.00	1.92
9	Spacing (45 × 45) cm ² + Silicon 1.5%	42785.00	98010.00	55225.00	1.29
10	Spacing (60 × 25) cm ²	44525.00	88630.00	44105.00	0.99

Conclusion

It is concluded that spacing (60 × 25) cm² along with silicon 1.0% (treatment 5) has recorded highest grain yield and benefit cost ratio in maize.

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References

- Azam M, Akabar N, Akhter MJ, Sajjad A. Production potential of various maize (*Zea mays* L.) hybrids under different row plant spacing. Pak Agri Sci. 2017;54(1):117-121.
- Bhat JA, Shivaraj SM, Singh P, Navadagi DB, Tripathi DK, Dash PK, *et al.* Role of silicon in mitigation of heavy metal stresses in crop plants. Plants (Basel). 2019;8(3):71-91.
- Chim BK, Omara P, Macnack N, Mullock J, Dhital S, Raun W. Effect of seed distribution and population on maize (*Zea mays* L.) grain yield. Int J Agronomy. 2014;10(8):1155-1162.
- Dwipa I, Karmaini S, Suliansyah I. Effect of plant spacing on growth and yield of hybrid maize (*Zea mays* L.). Asian Res J Agric. 2020;12(3):9-16.
- Gomez KA, Gomez AA. Three or more factor experiment. In: Statistical procedures for agricultural research. 2nd ed. 1976. p. 139-141.
- Gaire R, Pant C, Sapkota N, Dhamaniya R, Bhusal TN. Effect of spacing and nitrogen level on growth and yield of maize (*Zea mays* L.) in mid-hill of Nepal. Malays J Halal Res. 2020;3(2):2616-2623.
- Government of India (GOI). Agricultural statistics at a glance: Ministry of Agriculture, Government of India. 2022. Available from: <http://www.agricoop.nic.in>.
- Hasan MR, Rahman MR, Hasan AK, Paul SK, Alam AHMJ. Effect of variety and spacing on the yield performance of maize (*Zea mays* L.) in the old Brahmaputra floodplain area of Bangladesh. Arch Agric Environ Sci. 2018;3(3):270-274.
- Hassan HH, Huthily KH, Mohsen HK. Effect of humic acid and silicon on some growth characteristics of maize (*Zea mays* L.). Basrah J Agric Sci. 2019;32(2):23-32.
- Ion V, Dicu G, Dumbrava M, Temocico G, Alecu IN, Basa AG, *et al.* Harvest index at maize in different growing conditions. Rom Biotechnol Lett. 2015;20(6):10951-10960.
- Jawahar S, Suseendran K, Kalaiyarasan C, Ramesh S, Vinodkumar SR, Arivukkarasu K. Effect of silicon on dry matter yield and nutrient uptake of hybrid maize. Plant Arch. 2020;20(1):3211-3215.
- Jawhar AK, Aryan SA, Dizayee. Yield and growth indices of hybrid maize (*Zea mays* L.) as influenced by inter and intra row spacing. ZANCO J Pure Appl Sci. 2022;34(5):169-185.
- Johannes A, Postma VL, Hecht KH, Eric AN, Thijs LP, Poorter H. Dividing the pie: a quantitative review on plant density responses. J Exp Bot. 2021;44(4):1072-1094.
- Kumar SM, Karthikeyan R, Maragatham N. Effect of silicon fertilization on growth and yield of hybrid maize under irrigated and rainfed conditions. Madras Agric J. 2018;105(10):530-534.
- Koirala S, Dhakal A, Niraula D, Bartaula S, Panthi U, Mahato M. Effects of row spacings and varieties on grain yield and economics of maize. J Agric Nat Resour. 2020;3(1):209-218.
- Kalyani M, Mehera B, Kumar P. Effect of zinc and foliar application of silicon on growth and yield of maize (*Zea mays* L.). Int J Plant Soil Sci. 2023;35(5):141-146.
- Kumar PA, Mehera B, Kumar P. Effect of foliar application of boron and silicon on growth and yield of maize (*Zea mays* L.). Int J Plant Soil Sci. 2023;35(14):256-262.
- Manan J, Singh G, Sharma M, Singh. Effect of plant spacing on yield attributes of maize hybrid. J Krashi Vigyan. 2016;5(1):41-45.
- Nangial K, Han Y, Xing F, Feng L, Guoping W, Yang B, *et al.* Plant density influences reproductive growth, lint yield, and boll spatial distribution of maize. Agronomy. 2020;10(1):14-19.
- Prajapati BS, Kaushik MK, Sharma SK, Chaudhary R, Yadav SK, Meena SN, *et al.* Effect of active silica on performance of maize (*Zea mays* L.) under organic farming. Indian J Agric Sci. 2021;91(10):1519-1523.
- Prajapati BS, Kaushik MK, Sharma SK, Chaudhary R, Singh D, Bairwa D. Effect of active silica on profitability of maize under organic farming. Indian J Ecol. 2022;49(1):124-128.
- Purbajanti ED, Kristanto BA, Funun R. Evaluation of silica and zinc in growth and yield of maize. Ann Biol. 2022;38(2):206-211.
- Sally F, El-Ezz A, Haffez SH. Effect of nitrogen fertilization, proline, plant spacing, and irrigation intervals on growth of maize plant. J Soil Sci Agric Eng Mansoura Univ. 2019;10(8):447-456.

24. Singh PK, Singh P, Nath T. Effect of row spacing and mulching on the growth and growth attributes of maize (*Zea mays* L.) in eastern Uttar Pradesh. J Pharmacogn Phytochem. 2022;11(3):296-300.
25. United States Department of Agriculture (USDA). World agricultural production. 2024. Available from: <https://apps.fas.usda.gov>.
26. Wang M, Wang R, Mur LAJ, Ruan J, Shen Q, Guo S. Functions of silicon in plant drought stress responses. Horticulture Res. 2021;8:254.