International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 1269-1272

Received: 15-11-2020
Accepted: 21-12-2020

Effect of varying levels of silicon and restricted irrigation on productivity of wheat (*Triticum aestivum* L.) under *Bhal* condition of Gujarat

Ram Niwas Choudhary, Kinjal J Suthar, Sanjay D Doba and VD Maheriaya

Ram Niwas Choudhary
Agricultural Research Station, Anand Agricultural University Dhandhuka, Gujarat, India

Kinjal J Suthar
Agricultural Research Station, Anand Agricultural University Dhandhuka, Gujarat, India

Sanjay D Doba
Agricultural Research Station, Anand Agricultural University Dhandhuka, Gujarat, India

VD Maheriaya
Agricultural Research Station, Anand Agricultural University Dhandhuka, Gujarat, India

Corresponding Author:
Ram Niwas Choudhary
Agricultural Research Station, Anand Agricultural University Dhandhuka, Gujarat, India

DOI: https://doi.org/10.22271/chemi.2021.v9.i1r.11398

Abstract
A field experiment was conducted during *rabi* season 2019-20 at Agricultural Research Station, Anand Agricultural University, Dhandhuka, Gujarat, to evaluate the effect of different irrigation and silicon levels on wheat productivity. Results from the experiment indicate that significantly superior data were recorded with two irrigation (I_3) in case of plant height (75.85), effective tillers per plant (6.18), ear length (cm) (8.71), grains per ear (35.42), test weight (g) (46.29) and grain yield (3360 kg ha^{-1}) over control (I_1) and being at par with three irrigation (I_4). While 75% anthesis (73.33) and physiological maturity days (108.33) found significantly superior with three irrigation (I_4) over control (I_1) and being at par with two irrigation (I_3) 72.83 and 107, respectively. Amongst different levels of silicon, 150 kg ha^{-1} (S_3) significantly increased yield and yield attributes *i.e.*, plant height (72.24), effective tillers per plant (6.12), ear length (cm) (7.67), grains per ear (32.81), test weight (g) (46.17) and grain yield (3182 kg ha^{-1}) as compare to control (S_1) and being at par with three irrigation (S_4). The percent increase in case grain yield with silicon 150 kg ha^{-1}(S_3) is 40.29 over control (S_1). Alike, results further pointed out that 75% anthesis (71.25) and physiological maturity days (104.42) found significantly superior with silicon 200 kg ha^{-1}(S_4) over control (S_1) and at par with silicon 150 kg ha^{-1}(S_3).

Keywords: Wheat, irrigation, silicon and yield

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crop of the world on account of its wide adaptability to different agro-climatic conditions and different soil. Wheat is universally known as "King of cereals" due to its wider adaptability. The cultivation of wheat has also been symbolic of green revolution, self-sufficiency in food production. In India, it is the second most important food crop after rice in terms of its importance and role in food security. In global level, wheat also ranked second after rice crop in food grain production and it was grown in 220.4 million hectare area with the production of 768.49 million tonnes (FAOSTAT, 2020) [5]. In term of global level wheat production India stand second position after china. In India wheat grown on 30.55 million hectare area with production of 107.18 million tonnes and productivity 3508 kg ha^{-1} (Sharma *et al.*,2020) [12]. In India, Gujarat state gets seventh position in wheat production after Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Bihar and Rajasthan. In term of percentage, it accounts more than 4% of total production of the wheat in the country (Anon., 2020) [3]. In Gujarat, it is cultivated about 7.7 thousand hectare area with the production of 23.95 million tonnes and having productivity of 3082 kg ha^{-1} (Anon., 2019) [2] (Choudhary *et al.*, 2018) [4]. Silicon (Si) is gaining increased attention in the farming sector because of its beneficial effects observed in several crop species, particularly under stress conditions. Silicon (Si) is considered a non-essential element, but it has many useful functions in plants (Guntzer *et al.*, 2012) [7]. Plants take up Si in the form of monosilicic acid [Si(OH)4] via the roots (Ma *et al.*, 2006). Many of studies performed with several plant species and under diverse growth conditions have demonstrated the favorable benefits of Si fertilization, particularly in alleviating biotic and abiotic stresses (Fauteux *et al.*, 2005,) [6] (Singh *et al.*, 2013,) [13]. Si can increase plants capabilities stand with water stress because it decreasing the rate of transpiration process.

Transpiration from the leaves mainly occurs through the stomata and partly through the cuticle of the leaves forming a silicon-cuticle double layer, the transpiration through cuticle may decrease due to silica deposition (Ma, 2004).

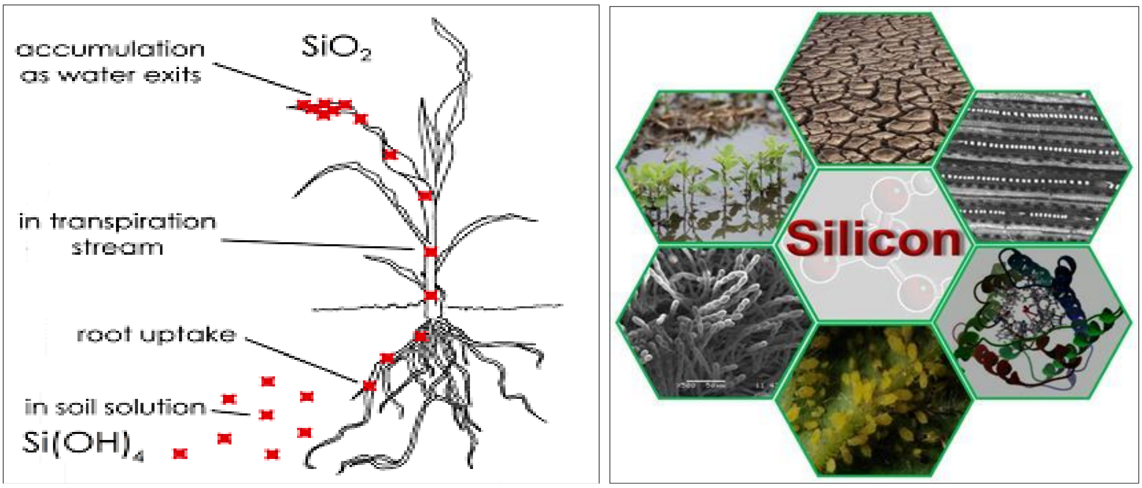

Fig 1: Representation of the movement of silicon from the soil solution through plant vascular system to leaf tips. Red symbols represent concentrations of silicon

Water helps in cell enlargement due to turgor pressure and cell division which ultimately increase the growth of plant. Water is essential for the germination of seeds, growth of plant roots, and nutrition and multiplication of soil organism. Water is essential in hydraulic process in the plant. Water is also essential for the transportation of nutrients and sugars from the soil to the plants. Irrigation recommended for wheat crop in accordance to their critical stages are namely at crown root initiation (21 DAS), tillering stage (40-45 DAS), jointing (60-65 DAS), flowering (80-85 DAS), milking (100-105 DAS) and dough stage (115-120 DAS). Irrigation given at crown root initiation stage is very important for successful growth of wheat and it has a great impact on higher grain yield (Randhawa *et al.*, 2004) [11].

Materials and Methods

The experiment was conducted *rabi* session 2019-20 at Agricultural Research Station, Anand Agricultural University, Dhandhuka, Gujarat which is situated at 22.5 N Latitude, 72.5 E Longitude and 39.78 Altitude. The region falls under Bhal & Costal Agro-climatic Zone VIII, Gujarat. The average rain fall of station is 625 mm, out of this (80-85%) is received through south-west monsoon during July to early September. The soil of the experiment field is medium black clay loamy with pH 8.7 and medium rang in available in nitrogen (215 kg ha^{-}), low in available phosphorus (5.46 kg ha^{-1}) and high in available potassium (475 kg ha^{-}) with 0.46% organic carbon. The experiment was laid out in split plot with four irrigation levels (I_1: no irrigation, I_2: one irrigation at CRI, I_3: two irrigation at CRI and booting stage and I_4: three irrigation at CRI, booting and milking stage) and four silicon levels (S_1: control, S_2: 100 kg ha^{-1}, S_3: 150 kg ha^{-1} and S_4: 200 kg ha^{-1}), assigned respectively to main and sub plots and those were replicated three times. The wheat variety "GW 451" was sown in third week of November. The recommended dose of nitrogen, phosphorous and potash was 90-60-40 kg ha^{-1}, respectively, which was applied through urea, DAP and MOP. During the season one third quantity of total nitrogen and whole amount of phosphorous and potash were applied as basal at sowing, while remaining quantity of nitrogen was applied in two split of equal quantity at first and second irrigation. The yield and yield attributes examine by randomly selecting five plants form each experimental plot, leaving the two border rows on the rows direction and half meter on opposite direction of the plot of wheat

Result and Discussion

(A) Effect of Irrigation levels

Plant population: Numerically higher number of plant stand/sq m at harvest was found with two irrigation (CRI and booting stage) (17.94) but, overall data was found no-significant in case of one irrigation (17.48), three irrigation (17.79) as well as control (17.07).

Plant height: An examination of the data revealed that irrigation levels differed significantly in their plant height at maturity stage. Significantly higher plant height (cm) was recorded with treatment I3 (Two irrigation at CRI and booting stage) was 75.85 cm over control (59.75 cm). I3 treatment (Two irrigation at CRI and booting stage) being statistically at par with I_4 treatment (75.49) (Three irrigation at CRI, booting and milking stage) but significantly higher than control. These findings are in agreement with Singh *et al*. (1980) [14].

Effective tillers per plant: It is apparent from the data given in Table 1 that the irrigation levels significantly influenced effective tillers per plant at harvest stage. Levels of two irrigation (I_3) being at par with levels of three irrigation (I_4). The data further indicated that significantly higher effective tillers were recorded with I_3 treatment (6.18) over control (5.70), representing an increase of 8.42 percent over no irrigation and found at par with I_4 treatment (5.85).

75% Anthesis and physiological maturity (Days after seeding): The maximum days to 75 per cent anthsis (73.33) and maturity (108.33) was significantly recorded under three irrigations(I_4), it was statistically at par with two irrigations (72.83) & (107) but significantly superior over control (62) &(94.25), respectively. Water is an elementary constituent of plant cell and their adequate supplies enhance cell division and as well as cell elongation. Therefore, optimum availability of water with two or three irrigations to wheat might have improved the photosynthetic area of plants that cumulatively contributed to higher plant height, effective tillers and anthesis and physiological maturity (Days after seeding). The results of this study are in close conformity by Sharma *et al.*, (2020) [12] and Mer *et al.*, (2014) [10].

Ear length (cm): A perusal of data (Table 2) fingered out significant influence of irrigation levels on ear length (cm) of wheat. Application of two irrigation (I_3 treatment) gave significantly higher ear length (8.17) over control (6.23) and found statistically at par with three irrigation (I_4 treatment) (8.09) and increase in the tune of 31.13 & 11.30 percent over control and one irrigation, respectively whereas three irrigation an increase of 29.85 percent over control.

Grains per ear: The analysis of variance of data indicated that irrigation levels had significant effect on grain per ear. Data clearly indicated (Table 2) that I_3 treatment (Two irrigation at CRI and booting stage) were recorded significantly higher data (35.42) in front off I_1 treatment (27.58) (no irrigation), and found statistically at par with I_4 treatment (three irrigation). Two irrigation at CRI and booting stage represented an escalation of 28.42 percent over no irrigation and 13.05 percent over one irrigation in the *Bhal* condition of Gujarat.

Test weight (g): It was clear from the results that I_3 treatments significantly influenced the test weight of wheat. Application of two irrigation (46.29) being at par with three irrigation (46.11) but significantly superior over no irrigation (44.24) and registered an upturn of 4.65 percent over no irrigation. These finding are closely confirm with Afzal A. and Kumar R. (2015) [1].

Grain Yield (kg ha^{-1}): Data pertaining to grain yield of wheat as influenced by varying levels of silicon and restricted are presented in Table 2. A close perusal of the results shows that application two irrigation (I_3) produced significantly higher grain yield (3360 kg ha^{-1}) over no irrigation (I1) (1919 kg ha^{-1}) which is being at par with three irrigation (I_4) (3247 kg ha^{-1}). Application of one irrigation (I2) (2605 kg ha^{-1}) found significantly superior over no irrigation (I1) (1919 kg ha^{-1}).

(B) Silicon levels

Plant population: Statistically maximum number of plant stand/sq m at harvest was associated with application of silicon 150 kg ha^{-1} (S_3 treatment) (17.73) but, overall data was found no-significant in case of control (17.58), S_2 (17.44) and S_4 treatment (17.53).

Plant height (cm): Data further reveled that (Table 1) significantly higher plant height were recorded with application of silicon 150 kg ha^{-1} (72.24) (S_3) over control (69.50) and being at par with application of silicon 200 kg ha^{-1} (72.14). In terms of plant height, deposition of silicon in cell wall can make the leaves and stems more erect and increase plant height even under drought conditions. Increase plant height can be attributed towards increased cell division and elongation caused by silicon. The results of this study are in close conformity by Sharma *et al.*, (2020) [12].

Effective tillers per plant: The analysis of variance of data indicated that silicon levels had significant effect on effective tillers. A critical examination of data further manifested that application of silicon 150 kg ha^{-1}(6.12) significantly increased effective tillers over control (5.57) and remarkable increase is 9.87 percent over control and found at par with application of silicon 100 kg ha^{-1}(5.87) and application of silicon 200 kg ha^{-1}(5.88)

75% Anthesis and physiological maturity (Days after seeding): The maximum (Table 1) days to 75% anthesis (71.25) was obtained with application of silicon 200 kg ha-^{1}, which was statistically at par with silicon 150 kg ha^{-1} (70.75)and but significantly superior over the control (68.17) and silicon 100 kg ha^{-1} (69.50). Physiological maturity days (105.42) was recorded significantly with application of silicon 200 kg ha-^{1} over the control (99.75) whereas, found at par with silicon 150 kg ha^{-1} (103.92) and silicon 100 kg ha^{-1}(102.33)

Ear length (cm): Data further reveled that due to application of silicon 150 kg ha^{-1}(7.67) ear length found significantly superior over control (7.14) and at par with silicon 200 kg ha^{-1}(7.55). Percent increase of silicon 150 kg ha^{-1} is 7.42 over control.

Grains per ear: Data clearly indicated (Table 2) that due to application of silicon there was a significant improvement in the grains per ear, wherein; application of silicon 150 kg ha^{-1} (S_3) (32.81) recorded appreciably grains per ear over control (S_1) (30.48) and being at par with application of silicon 200 kg ha^{-1} (S_4) (32.38). Application of silicon 150 kg ha^{-1} (S_3) (32.81) represented an escalation of 7.64 percent over control.

Test weight (g): Data pertaining to test weight of wheat as influenced by application of silicon are presented in Table 2. A perusal of the data also exhibited that application of silicon 150 kg ha^{-1} (S_3) (46.17) significantly increased the test weight of wheat over no application of silicon or control (S_1) (43.92) and found at par with application of silicon 200 kg ha^{-1} (S_4) (45.80), whereas, S_2 (45.51) & S_4 (45.80) treatment also found significantly superior (43.92) over no application of silicon or control (S_1). The magnitudes of increase in test weight due to application of silicon 150 kg ha^{-1} is 5.12 percent higher over control.

Table 1: Effect of irrigation and silicon levels on plant stand, plant height, effective tillers/plant**,** 75% anthesis and physiological maturity of wheat

Treatment	Plant Stand /sq.m. at harvest	Plant height(cm) at harvest	Effective tillers/plant	75% Anthesis (Days after seeding)	Physiological Maturity (Days after seeding)
Irrigation levels					
I_1 = No irrigation	17.07	59.75	5.70	62.00	94.25
I_2 = One irrigation	17.48	73.24	5.70	71.50	100.83
I_3 = Two irrigation	17.94	75.85	6.18	72.83	107.00
I_4 = Three irrigation	17.79	75.49	5.85	73.33	108.33
S.Em±	0.307	0.258	0.083	0.329	0.809
CD (P=0.05)	NS	0.893	0.288	1.138	2.801
Silicon levels					

S_1 = Control	17.58	69.50	5.57	68.17	99.75
S_2 = 100 kg ha^{-1}	17.44	70.45	5.87	69.50	102.33
S_3 = 150 kg ha^{-1}	17.73	72.24	6.12	70.75	103.92
S_4 = 200 kg ha^{-1}	17.53	72.14	5.88	71.25	104.42
S.Em±	0.278	0.326	0.093	0.232	0.818
CD (P=0.05)	NS	0.952	0.270	0.677	2.388

Table 2: Effect of irrigation and silicon levels on yield and yield attributes of wheat

Treatment	Ear length (cm)	Grains/ear	Test weight (g)	Grain yield (kg/ha)
Irrigation levels				
I_1 = No irrigation	6.23	27.58	44.24	1919
I_2 = One irrigation	7.34	31.33	44.77	2605
I_3 = Two irrigation	8.17	35.42	46.29	3360
I_4 = Three irrigation	8.09	32.45	46.11	3247
S.Em±	0.136	0.466	0.244	142
CD (P=0.05)	0.472	1.611	0.85	491
Silicon levels				
S_1 = Control	7.14	30.48	43.92	2268
S_2 = 100 kg ha^{-1}	7.47	31.11	45.51	2839
S_3 = 150 kg ha^{-1}	7.67	32.81	46.17	3182
S_4 = 200 kg ha^{-1}	7.55	32.38	45.80	2842
S.Em±	0.107	0.344	0.222	99
CD (P=0.05)	0.312	1.004	0.648	288

Grain Yield (kg ha^{-1}): In case of silicon the maximum grain yield (3182 kg ha-1) were recorded under application of silicon 150 kg ha^{-1}, it was statistically at par with silicon 200 kg ha^{-1}(2842 kg ha-1) but significantly superior over control (2268 kg ha-1). The increase in grain yield of wheat might be attributed to the increase in growth and yield characteristics of wheat and also to the stimulating effect of silicon in reducing biotic and abiotic stress. Silicon application may enhance crop yield by several indirect action such as decreased shading due to greater leaf erectness. Erectness of leaves as a result of silicon fertilization improves the photosynthesis, thereby indirectly increasing yield. Sharma *et al.*, (2020) [12].

References

1. Afzal Ahmad, Ramesh Kumar. Effect of irrigation scheduling on the growth and yield of wheat genotypes. Agric. Sci. Digest 2015;35(3):199-202.
2. Anonymous 2019. https://dag.gujarat.gov.in/images/directorofagriculture/pdf/APY-2016-17-2017-18-2018-19-for-website.pdf
3. Anonymous 2020. https://www.trendrr.net/643/top-10-largest-wheat-producing-states-in-india-famous-highest-production/
4. Choudhary Ram Niwas, Patel NJ, Suthar KJ. effect of PGRs and chemicals on yield and yield attributes of durum wheat under conserved moisture condation of Bhal region of Gujarat. XXI Biennial National Symposium of Indian Society of Agronomy, MPUAT, Udaipur 2018, PP254
5. FAOSTAT (Food and Agriculture Organization Statistics) Crops harvested. Food and Agricultural Organization Statistical Service 2020. (http://www.fao.org/faostat/en/#home; retrieved on dated 12-10-2020)
6. Fauteux F, Rémus-Borel W, Menzies JG, Bélanger RR. Silicon and plant disease resistance against pathogenic fungi. FEMS Microbiol. Lett 2005;249:1–6. doi: 10.1016/j.femsle.2005.06.034
7. Guntzer F, Keller C, Meunier JD. Benefits of plant silicon for crops: a review. Agron. Sustain. Dev. 2012;32:201–213. doi: 10.1007/s13593-011-0039-8
8. Ma JF, Tamai K, Yamaji N, Mitani N, Konishi S, Katsuhara M. A silicon transporter in rice. Nature 2006;440:688–691. doi:10.1038/nature04590
9. Ma JF. Role of silicon in enhancing the resistance of plants to biotic and abiotic stresses. Soil Science and Plant Nutrition 2004;50(1):11-18
10. Mer M, Ama EE. Effect of different irrigation regime on grain yield and quality of some Egyptian bread wheat cultivars. Journal of Agriculture Food and Applied Science 2014;2(9):275-282.
11. Randhawa AS, Jolly RS, Arora BS. The effect of sowing time and rates and time of nitrogen application on dwarf wheat. Journal Research Punjab Agriculture University 2004;13(2):130−135.
12. Sharma R, Choudhary J, Singh D, Meena SC, Kumar Vijay. Performance of Wheat (*Triticum aestivum* L.) under Varying Levels of Silicon and Restricted Irrigation. Int. J Curr. Microbiol. App. Sci 2020;9(11):285-293.
13. Singh Surendra, Singh, Harphool, Choudhary, Ramniwas. Heat stress management in late sown wheat (*Triticum aestivum*) under climate change Scenario. Annals of Agri- Bio Research 2013;18(2):135-138.
14. Singh RP, Dhiman SD, Sharma HC. Performance of wheat varieties under limited water supply. Indian Journal of Agronomy 1980;25:259-262.