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# Influence of Silicon on Leaf Blast of Rice (*Pyricularia grisea*) and their Relationship on Morph physiological and Yield Parameters under Drought stress

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**ABSTRACT**

Rice (*Oryzae sativa* L.) is the staple food crop of over half of the world's population and also widely cultivated across the world, making it possibly the most valuable plant on earth. Silicon is essential element it can defense against biotic and abiotic stress in many crops and their diseases. In the present study Silixol @ 0.3%, 0.6%, 0.9% and 1.2% were evaluated against *Pyricularia grisea* in different period of incubation for the assessment of mycelial growth and Sporulation in Potato Dextrose agar medium. Among five concentrations Silixol @ 0.6% showed inhibition of mycelial growth over control. Silixol @ 0.6% were applied to nine genotypes. Treatments with (T2 irrigated+0.6Silixol) and (T3 drought+0.6 Silixol) enhanced growth parameters and Morph physiological and Yield Parameters under Drought stress however (T2 irrigated+0.6 Silixol) recorded minimum disease incidence and it can be correlated with weather parameters.

***Key words:*** *Rice, Silicon, Leaf Blast, Pyricularia grisea, Silixol*

## Introduction

Rice (*Oryzae sativa* L.) is the staple food crop of over half of the world's population and also widely cultivated across the world, making it possibly the most valuable plant on earth. It provides 20 percent of the world's supply of dietary energy followed by maize and wheat. Rice grows in at least 114 countries and more than 50 have a capacity of 100,000 tons or more per year. The production of rice is estimated to be 128 Mt by 2025 to meet out the food requirement of growing population in India. It contributes 40% of total food grain production and cover 42% of the total cropped area. The area of rice production in the world is 162.34mha with production 542.57 million tons and productivity 4530kg/ha (United States Department of Agriculture and Foreign Agricultural Service 2017-18). In Madhya Pradesh, rice is being grown in area of 1.93 mha with production of 2.74 million tons and productivity 1768kg/ha (Ministry of Agriculture, Annual Report, 2017-18). The exploitation of local traditional varieties under upland ecosystem, improved susceptible varieties and poor agronomical practices are considered for the outbreak of leaf blast (*Pyricularia grisea*) causing 70-80% yield losses and becoming a major (Padmanabhan 1965; Kihoro *et al.,* 2013). The disease severity may be influenced by different factors like host resistance, soil types and weather conditions. Among the soil nutritional limiting factors Silicon (Si) is the second most abundant element available in soil and it is considered as an absolutely useful element for a large variety of plant (Nakata *et al.,* 2008). Silicon used from soil in high amounts that higher than those of other nutrients in crops and its can prevent from under biotic and abiotic stress conditions. Si essential element effect of on plants, besides increasing their fitness in nature and also productivity. There has been a considerable amount of research showing the positive effect of Si in controlling leaf blast of rice. The first hypothesis is a mechanical barrier against appressorial penetration and second hypothesis is physiological roles in disease resistance (Ashtiani *et al.,* 2012*).* Keeping these facts in view, the study was under taken with the following experiment.

## Materials and Method

### Experimentation site

The present study on "Influence of Silicon on leaf blast of rice (*Pyricularia grisea*) and their relationship on morpho physiological and yield parameters under drought stress." was carried out during kharif 2019-20 at All India Coordinated Rice Improvement Project, College of Agriculture, Rewa (M.P.). The topography of the experimental site was fairly leveled. The soils are normal with pH value 7.3 and electrical conductivity varied from 0.37-0.44 dSm$^{-1}$ at 25$^{0}$C. The soils are low in available nitrogen, medium in available $P_2O_5$. Field and Laboratory experimental data were statistically analysed by following the Complete Randomized Design and Split Plot Design (Panse and Sukhatme, 1967).

| | | | |
|---|---|---|---|
| a) | Texture | : | Silty clay loam |
| b) | WP | : | 17.0 per cent (V/V) |
| c) | FC | : | 31.0 per cent (V/V) |
| d) | Soil depth | : | 3 m |
| e) | Organic carbon | : | 0.56-0.60 per cent |

### Climate and weather conditions

Rewa is situated in North Eastern part of Madhya Pradesh at 24$^{o}$ 31′ North latitude, 81$^{o}$15′ East longitude and 360 meters above mean sea level. It has sub tropical climate with hot and dry summer and cold winters which are the main features of the region. The average annual rainfall of the region is 1200 mm. The total rainfall throughout the cropping season was 850.8 mm received in 41 rainy days in *Kharif*. The maximum and minimum temperature recorded during the crop season was 41.03ºC and 10.74 ºC in the month of June and December respectively.

### Meteorological data

The meteorological data (Maximum temperature, minimum temperature relative humidity and rainfall) for the *kharif* season, 2019 were obtained from the Department of Agricultural Meteorology, JNKVV, College of Agriculture, Rewa.

### Evaluation of rice germplasm against leaf blast of rice under drought stress

The experiment was conducted with Nine genotypes viz: V1-IIRRH122, V2-IIRRH131, V3-IIRRH132, V4-HRI174, V5- KRH4, V6-JKRH3333, V7-US314, V8-27P63, V9-Sahabhagidhan and field maintain design spilt plot with application of Fertilizer : 100:45:60, N: P: K (kg/ha), Sub-plot treatment 4 (Silixol) and observations to be recorded weather parameters like Rainy days, Rainfall (mm), Maximum and minimum temperature Relative humidity (%) and also recorded Morph physiological parameters like Germination %, Root and shoot length(cm), Seedling vigour index, Plant height(cm), Leaf area index (LAI), No. of tiller/plant, Relative water content (RWC), Membrane stability index (MSI) and Yield components Total dry matter (TDM)g, No. of panicle/plant, No. of grain/panicle, 1000 grain weight(g), Grain yield(q/ha) and HI (harvest index) percent.

**Silicon Treatment:** T1-Control, T2-Spray at 0.6% silicon at tillering, PI, 50% flowering and milky grain stage, T3-Silicon + water stress water stress to be imposed by withholding irrigation T4-Water stress only.

***In vitro* studies:** Seed germination study was carried out *In vitro* by using mannitol 1% solution along with Silicon different treatment combinations. Mannitol was used to induce drought stress and Silicon was used as Silixol formulation @0.6% and distilled water was used for untreated check for evaluation of seed germination, root /shoot length and seedling vigour index. Twenty seeds of each tested genotypes (09) were placed in petridishes (90mm) and treated with different treatment combinations for the study. Germination was finally recorded in each genotypes

Weekly meteorological data during kharif season 2019-2020

| Standard Week | Period From | Period To | Temperature (°C) Max. | Temperature (°C) Min. | Rainfall (mm) (mm) | Rainy days | Relative humidity Min.(%) | Relative humidity Max.(%) |
|---|---|---|---|---|---|---|---|---|
| 23 | 04-Jun | 10-Jun | 41.03 | 25.83 | 22.6 | 1 | 27.86 | 38.57 |
| 24 | 11-Jun | 17-Jun | 40.97 | 26.29 | 11.6 | 3 | 34.86 | 44.86 |
| 25 | 18-Jun | 24-Jun | 38.28 | 24.54 | 49.6 | 4 | 39.00 | 62.86 |
| 26 | 25-Jun | 01-Jul | 35.69 | 23.51 | 70.6 | 4 | 60.14 | 71.57 |
| 27 | 02-Jul | 08-Jul | 30.97 | 24.27 | 67.8 | 2 | 65.29 | 82.29 |
| 28 | 09-Jul | 15-Jul | 29.01 | 22.93 | 296.0 | 5 | 76.86 | 86.71 |
| 29 | 16-Jul | 22-Jul | 33.51 | 23.96 | 96.6 | 6 | 69.71 | 78.29 |
| 30 | 23-Jul | 29-Jul | 30.37 | 22.81 | 51.2 | 4 | 76.43 | 87.14 |
| 31 | 30-Jul | 05-Aug | 32.34 | 24.10 | 7.2 | 1 | 64.43 | 81.43 |
| 32 | 06-Aug | 12-Aug | 31.69 | 24.27 | 17.4 | 2 | 72.57 | 84.86 |
| 33 | 13-Aug | 19-Aug | 32.67 | 24.34 | 0 | 0 | 60.29 | 78.57 |
| 34 | 20-Aug | 26-Aug | 33.69 | 23.99 | 63.6 | 2 | 63.29 | 78.00 |
| 35 | 27-Aug | 02-Sep | 32.56 | 23.65 | 2.2 | 1 | 59.29 | 80.86 |
| 36 | 03-Sep | 09-Sep | 34.43 | 23.08 | 23.4 | 1 | 57.86 | 74.29 |
| 37 | 10-Sep | 16-Sep | 34.89 | 23.40 | 21.8 | 2 | 66.86 | 77.00 |
| 38 | 17-Sep | 23-Sep | 32.70 | 23.10 | 49.2 | 3 | 72.00 | 85.14 |
| 39 | 24-Sep | 30-Sep | 34.00 | 21.19 | 0 | 0 | 50.71 | 76.86 |
| 40 | 01-Oct | 07-Oct | 34.49 | 21.46 | 0 | 0 | 54.29 | 77.29 |
| 41 | 08-Oct | 14-Oct | 34.43 | 21.76 | 0 | 0 | 54.00 | 79.57 |
| 42 | 15-Oct | 21-Oct | 34.99 | 18.61 | 0 | 0 | 54.43 | 68.43 |
| 43 | 22-Oct | 28-Oct | 35.14 | 16.23 | 0 | 0 | 40.29 | 59.71 |
| 44 | 29-Oct | 04-Nov | 31.50 | 14.54 | 0 | 0 | 47.43 | 70.29 |
| 45 | 05-Nov | 11-Nov | 30.89 | 13.16 | 0 | 0 | 49.71 | 71.86 |
| 46 | 12-Nov | 18-Nov | 29.71 | 13.74 | 0 | 0 | 50.00 | 70.00 |
| 47 | 19-Nov | 25-Nov | 27.73 | 10.74 | 0 | 0 | 50.71 | 70.57 |
| 48 | 26-Nov | 02-Dec | 27.90 | 8.78 | 0 | 0 | 38.43 | 63.29 |
| 49 | 03-Dec | 09-Dec | 26.43 | 10.36 | 0 | 0 | 36.57 | 67.86 |
| 50 | 10-Dec | 16-Dec | 26.96 | 11.19 | 0 | 0 | 31.71 | 75.29 |
| 51 | 17-Dec | 23-Dec | 24.67 | 8.40 | 0 | 0 | 34.14 | 75.00 |
| 52 | 24-Dec | 31-Dec | 24.78 | 7.23 | 0 | 0 | 43.00 | 81.75 |
| | | | 32.3 | 19.4 | 850.8 | 41 | 53.4 | 73.3 |

*Source:* Meteorological Observatory, College Farm, Rewa (M.P.)

after seven days of plating and root /shoot length was recorded after 21days after plating .Seedling vigour index was calculated by using the formula: Seedling vigour index = (Root length + Shoot length) X germination % value was computed using the formula suggested by (Abdul-Baki and Anderson, 1973).

**Field studies: (I) Plant height (cm):** Height of the five tagged sample plants were measured in centimetre at 50% flowering stage with the help of wooden scale and their mean value were worked out. Height of the main shoot of the sample plant was measured from the base of the plant to tip of the longest leaf. After panicle emergence, it was measured from base of the plant to tip of the panicle.

**(ii) Number of tillers/plants:** Number of tillers per hill was recorded for the five tagged plants at and 90 DAT and average was worked out. Each shoot arising from the plant was counted as tillers including the main shoot. The tillers/m$^2$ was also counted in each treatment from three random spots and average was calculated.

**(iii) No. of tillers/m$^2$**: Tillers bearing panicles were counted as effective tillers from each sample/hill and averages were worked out. The tillers/m$^2$ was also counted in each treatment from three random spots and average was calculated.

**(iv) Length of panicle (cm):** The length of panicle was measured in centimeter from the base of rachis to tip of the panicle. The length of five sample panicles was measured and average was worked out.

**(v) Grain yield (q/ha):** The yield of grains obtained from each net plot was recorded in kilograms after

**Fig. 3.** Layout plan of the field experiment

2 M

| R1 | R2 | R3 | R1 | R2 | R3 |
|---|---|---|---|---|---|
| V8 | V1 | V4 | V9 | V1 | V4 |
| V7 | V2 | V3 | V8 | V2 | V3 |
| V6 | V3 | V2 | V7 | V3 | V2 |
| V5 | V4 | V1 | V6 | V4 | V1 |
| V4 | V5 | V9 | V5 | V5 | V9 |
| V3 | V6 | V8 | V4 | V6 | V8 |
| V2 | V7 | V7 | V3 | V7 | V7 |
| V1 | V8 | V6 | V2 | V8 | V6 |
| V9 | V9 | V5 | V1 | V9 | V5 |
| | T3 | | | T2 | |

2 M

| R1 | R2 | R3 | R1 | R2 | R3 |
|---|---|---|---|---|---|
| V9 | V1 | V4 | V9 | V1 | V4 |
| V8 | V2 | V3 | V8 | V2 | V3 |
| V7 | V3 | V2 | V7 | V3 | V2 |
| V6 | V4 | V1 | V6 | V4 | V1 |
| V5 | V5 | V9 | V5 | V5 | V9 |
| V4 | V6 | V8 | V4 | V6 | V8 |
| V3 | V7 | V7 | V3 | V7 | V7 |
| V2 | V8 | V6 | V2 | V8 | V6 |
| V1 | V9 | V5 | V1 | V9 | V5 |
| | T4 | | | T1 | |

sun drying of grains and the grain yield per plot was converted into quintal per hectare.

**Disease incidence**: Disease incidence was recorded as per SES (IRRI, 2013, Singh *et al*., 2013).

ScorePercent Leaf area covered

0 No lesions

1 Small brown specks pinhead size without sporulating centre

2 Small, roundish to slightly necrotic grey spots, about 1 -2mm in Diameter, with distinct brown margin, lesions are mostly found on lower leaves.

3 Lesion type is same as in scale 2, but significant number lesions are onthe upper leaves.

4 Typical sporulating blast lesions, 3mm or longer, infecting <2% of the leaf area

5 Typical Blast lesions infecting 2-10% of leaf area.

6 Blast lesions infecting 11-25% of leaf area.

7 Blast lesions infecting 25-50% of leaf area.

8 Blast lesions infecting 51- 75% of leaf area.

9 More than 75% leaf area affected.

**The percent disease index (PDI) was calculated by adopting the formula**

$$\text{PDI} = \frac{\text{Sum of numerical ratings}}{\text{Total numbers of plants observed} \times \text{maximum disease rating}} \times 100$$

The disease index (%) value was transformed by adopting the angular transformation.Ten observations were maintained for each variety and averages were recorded for disease observations.

**Apparent infection rate (r):** Apparent infection rate (r) per day was calculated by relative lesion height using the formula given by Van der Plank (1963).

$$r = (2.3 \frac{X_2}{(t_2 - t_1)\, X_1} \quad \mathrm{Log}_e)$$

Where, r is the apparent infection rate per day, $t_1$ and $t_2$ is the initial and final time for disease recorded and $X_1$ and $X_2$ are the proportions of lesion height at time $t_1$ and $t_{2,}$ respectively.

**Area under Disease Progress Curve (AUDPC)** was calculated with the formula given by (Lal Ahamed, *et al*., 2004)

$$\text{AUDPC} = \sum_{i=1}^{n-1} [\{(X_i + X_{(i+1)}/2\}\, (t_{(i+1)} - t_i)]$$

Where, $X_i$ is the Rice blast severity on the date, $t_i$ is the day and the number of scoring days

## Results and Discussion

### Influence of Silixol on mycelial growth of *Pyricularia grisea*

Four different concentrations of Silixol @ 0.3%, 0.6%, 0.9% and 1.2% were evaluated against *Pyricularia grisea* in different period of incubation for the assessment of mycelial growth and Sporulation in Potato Dextrose agar medium (Table 1) and compared with standard fungicide Carbendazim 50WP@0.1% over untreated check. Among the treatment, Silixol@0.9% gave optimum mycelia growth (59.3mm) followed by Carbendazim (56.6mm) over Control (67.9 mm). It was noted that minimum mycelial growth was observed in Silixol@0.6% (32.4 mm) at 144 hrs of incubation over standard fungicide check Carbendazim (36.6mm) and untreated check (77.9mm). None of the Silixol sources induced the sporulation of *Pyricularia grisea and* except Silixol@0.6% where sporulation was observed in traces. Sharma, *et al.* (2021) reported ortho silicic acid (2.0%) against thirteen fungal pathogens viz *Alternaria alternata, Alternaria macrospora, Alternaria solani, Cercospora arachidicola, Colletotrichum gloeosporioides, Corynespora cassiicola, Curvularia lunata, Mycosphaerella fragariae Bipolaris sorokiniana, , , Phoma obscurans, Mycopshaerella musicola Phyllosticta arachidis-hypogaeae,* and *Pyricularia oryzae*) using Poison Food Technique. Out of thirteen pathogens, eight exhibited more than 50% inhibition of mycelial growth and Kedarnath *et al*., 2016 reported that silicon reduction of mycelial growth of *Phytophthora infestans* on V-8 medium poisoned with OSA was reported earlier and Wainwright, (1997) observed that *Aspergillus oryzae* solubilized silicon compounds in both ultra-pure water and nutrient-rich media. Although interactions between microorganisms and the results show that silicon compounds can increase fungal growth under both oligotrophic and nutrient-rich conditions.

**Influence of Silicon on growth parameters and physiological activity of rice genotypes (*In-vitro conditions*)**

**Germination (%):** Maximum germination per cent was recorded by most of the genotypes treated with ($T_2$ Irrigated + 0.6% Silixol) followed by $T_3$ (Drought + 0.6% Silixol) over $T_4$ (Drought) however non significant interaction was found in T1Control (Table 2). Whereas T2 (Irrigated + 0.6% Silixol) condition maximum germination percentage were recorded genotypes were US-314 (89%), Sahabhagidhan (89%), JKRH3333 (88%) and KRH-4 (88%), Moreover, under drought condition these genotypes least germination percent were recorded 68%, 71%, 72% and 79% respectively.

**Seedling Vigour Index (Root length $_+$Shoot length)**: The data presented (Table 2) that treated ($T_2$ Irrigated + 0.6% Silixol) influenced seedling vigour index was recorded genotypes that 27P63 (3379), SAHABHAGIDHAN (3340) followed by US-314(3195) over T4 (Drought) treated genotypes, However $T_3$ (Drought + 0.6% Silixol) also influenced seedling vigour index was recorded genotypes SAHABHAGIDHAN (2741) and 27P63(2683) over drought conditions.

**Influence of Silicon on growth parameters and physiological activity of rice genotypes (*In-vivo conditions*)**

**Plant Height:** The effect of 0.6% Silixol on plant height (Table 1) was compared with two different conditions (ie., irrigated and drought) and it was found that 0.6% Silixol application increased plant height in all the nine genotypes in both the conditions. The maximum percent reduction in plant height was recorded under drought condition (6.9%)

**Table 1.** Effect of Silixol on mycelial growth of *Pyricularia grisea*

| S. No. | Treatment | Mycelial growth diameter (mm) | | | | |
|---|---|---|---|---|---|---|
| | | Period of incubation | | | | |
| | | 72 Hrs | 96Hrs | 120 Hrs | 144 Hrs | Sporulation |
| 1 | Silixol@0.3% | 50.4 (45.01) | 51.2 (47.03) | 52.8 (48.18) | 53.2 (48.34) | None |
| 2 | Silixol@0.6% | 29.4 (23.12) | 30.1 (26.56) | 30.2 (27.01) | 32.4 (28.08) | Traces |
| 3 | Silixol@0.9% | 57.2 (51.03) | 58.1 (54.12) | 58.2 (54.17) | 59.3 (54.28) | None |
| 4 | Silixol@1.2% | 52.8 (47.17) | 53.1 (48.12) | 55.2 (51.87) | 57.5 (52.4) | None |
| 5 | Carbendazim50 WP @0.1% | 35.2 (28.12) | 35.7 (30.78) | 36.1 (32.04) | 36.6 (32.12) | None |
| 6 | Control | 73.4 (58.19) | 75.2 (59.12) | 76.3 (59.17) | 77.9 (59.28) | None |
| | Mean | 51.4 | 52.2 | 53.13 | 54.4 | |
| | CD at 5%; CV % | 1.10<br>2.77 | | | | |

as compared to irrigated condition. It is obvious from the table that plant height was comparatively increased by the application of Silixol in both irrigated and drought conditions. The maximum percent increase in plant height was recorded in drought condition under applied Silixol in the genotypes IRRH132, (6.3%),27P63(5.2%) and KRH4 (5.0%) over irrigated condition where HRI174 (3.9%), IRRH132(3.3%) and IRRH131(3.3%) maximum percent increase was recorded. However, minimum percent increase in plant height was exhibited by the genotypes JKRH3333(0.8%) under irrigated conditions and HRI 174 (2.4%) in drought conditions.

**Table 2.** Influence of Silicon on Seed Germination and Seedling Vigour Index of rice genotypes.

| Treatment | Entries | Germination (%) | Root length (cm) | Shoot length (cm) | Seedling Vigour Index |
|---|---|---|---|---|---|
| T1(Control) | IIRRH-122 | 87 | 18.8 | 22.6 | 3615 |
| | IIRRH-131 | 85 | 18.3 | 21.5 | 3390 |
| | IRRH-132 | 87 | 18.4 | 21.9 | 3517 |
| | HRI-174 | 84 | 18.3 | 22.0 | 3401 |
| | KRH-4 | 88 | 18.4 | 21.6 | 3527 |
| | JKRH-3333 | 88 | 18.1 | 20.6 | 3422 |
| | US-314 | 89 | 17.9 | 20.9 | 3462 |
| | 27P63 | 87 | 18.7 | 22.6 | 3610 |
| | SAHABHAGIDHAN | 89 | 18.9 | 23.8 | 3818 |
| Mean | | **87** | **18.4** | **21.9** | **3529** |
| T2 (Irrigated + 0.6% Silixol) | IIRRH-122 | 86 | 17.4 | 18.8 | 3105 |
| | IIRRH-131 | 84 | 16.4 | 19.3 | 2990 |
| | IRRH-132 | 85 | 16.5 | 19.5 | 3064 |
| | HRI-174 | 82 | 17.0 | 19.0 | 2967 |
| | KRH-4 | 87 | 17.3 | 17.5 | 3019 |
| | JKRH-3333 | 85 | 16.3 | 17.8 | 2891 |
| | US-314 | 88 | 16.3 | 20.1 | 3195 |
| | 27P63 | 86 | 18.0 | 21.4 | 3379 |
| | SAHABHAGIDHAN | 87 | 17.8 | 20.4 | 3340 |
| Mean | | **85** | **17.0** | **19.3** | **3105** |
| T3( Drought + 0.6% Silixol) | IIRRH-122 | 81 | 14.2 | 17.8 | 2603 |
| | IIRRH-131 | 78 | 12.1 | 16.9 | 2258 |
| | IRRH-132 | 83 | 13.4 | 17.5 | 2569 |
| | HRI-174 | 81 | 13.6 | 17.6 | 2539 |
| | KRH-4 | 84 | 14.0 | 17.2 | 2633 |
| | JKRH-3333 | 83 | 12.8 | 15.7 | 2374 |
| | US-314 | 81 | 13.5 | 16.0 | 2385 |
| | 27P63 | 81 | 15.1 | 18.2 | 2683 |
| | SAHABHAGIDHAN | 81 | 14.6 | 19.3 | 2741 |
| Mean | | **81** | **13.7** | **17.3** | **2531** |
| T4 (Drought) | IIRRH-122 | 73 | 13.5 | 17.8 | 2274 |
| | IIRRH-131 | 71 | 12.3 | 16.8 | 2056 |
| | IRRH-132 | 77 | 12.4 | 16.2 | 2193 |
| | HRI-174 | 73 | 12.9 | 18.1 | 2273 |
| | KRH-4 | 79 | 12.7 | 17.0 | 2331 |
| | JKRH-3333 | 72 | 12.5 | 15.3 | 2006 |
| | US-314 | 68 | 12.6 | 15.0 | 1878 |
| | 27P63 | 68 | 13.5 | 17.5 | 2098 |
| | SAHABHAGIDHAN | 71 | 13.9 | 19.1 | 2340 |
| Mean | | **77** | **12.9** | **16.9** | **2161** |
| CD (0.05%) | T | 1.56 | 0.274 | 0.389 | 76.697 |
| | G | 2.34 | 0.410 | 0.583 | 115.045 |
| | TXG | NA | NA | 1.166 | NA |

**Leaf area index:** It was measured in both ecology in the tested genotypes under study. It is obvious from the data (Table 2) that the genotypes varied in the both ecology after the application of Silixol. However, the superiority of genotypes was recorded in irrigated conditions under Silixol as compared to drought conditions. The genotypes that had shown high leaf area index were IIRRH131(7.79) followed by JKRHJ3333 (7.60), IIRRH131(7.58) and US 314(7.33) under irrigated Silixol application whereas, minimum leaf area was recorded in KRH4(4.19), JKRH3333(5.27) and IIRRH122(5.30) under drought condition.

**Tillers number per plant:** The data (Table 2) indicate that application of Silixol @ 0.6% did not much influence the tillers number per plant under irrigated condition. However, it was significantly increased tillers number per plant in all nine tested genotypes under drought condition over untreated check. Maximum number of tillers per plant was recorded in 27P63 (13) followed by Sahabhagidhan (12), HRI 174(12) and US 314 (11) under drought condition with the 0.6% Silixol application, whereas, under drought condition same genotypes gave 7, 9, 8 and 9 tillers number per plant respectively.

**Relative Water content:** The data presented in (Table 2) reveal that the relative water content (%) in the leaves of the nine experimental genotypes decreased significantly under drought condition compared with irrigated condition. Application of Silixol @ 0.6% significantly increased the RWC in almost all tested genotypes under both the conditions. Among the tested genotypes, maximum percent increase in RWC in response to 0.6% Silixol was recorded in genotypes, JKRH 3333 (8.6%), IRRH 132 (5.9%) and IIRRH 131(3.7%) under irrigated condition over without application of Silixol under irrigated condition. However, maximum percent increase in RWC in response to 0.6% Silixol under drought condition was recorded in genotypes, KRH 4 (8.5%), 27P63 (7.2%), Sahbhagidhan (7.4%) and US 314 (5.7%) as compared to only drought condition.

**Membrane stability index (MSI)**: Data presented in regard to membrane stability index (MSI)in (**Table 2.1**) indicate that drought condition significantly reduced the MSI of leaves of all tested genotypes, data shows that average mean value of MSI under irrigated condition is 84% and 70% was recorded under drought condition. Application of Silixol @0.6% increases significantly MSI of leaves of all tested genotypes under drought condition. Maximum percent increase was recorded in genotypes, 27P63 (14.5%) followed by Sahbhagidhan (9.4%), IRRH 132 (8.3%) and KRH 4 (4.3%) under drought condition with the application of 0.6% Silixol as compared to drought ones.

The reduction in germination under drought stress might be due to an osmotic effect. It may also affect the many common reactions in plants and leads to cellular dehydration which causes osmotic stress and removal of water from the cytoplasm into the extracellular space. Similar results were reported by Dahanayake *et al*. (2015) in mung bean and supported the present findings. This may be explained on the basis of the fact that Increased germination under Silixol application might be due to seed soaking with silicon through Silixol plus enhanced the cell extension through formatting Si-polyphenol complexes and lignin which caused loosening of cell wall as a resulting the increase in higher germination percentage. Jawahar *et al.* (2015) in which he was stated that application of Silixol granules increased the root length and shoot length .Similar results were also obtained by Yavarzadeh.*et al.* (2008) who reported that increase in plant height could be due to deposition of silica on the plant tissues causing erectness of leaves and stem. These results are in accordance with the findings reported by Sajitha Biju *et al*., 2017 who worked on lentil in which the seedling vigour were significantly improved by Si application. Many researchers have concluded that Si has positive effect on the physiology and metabolism of different plants against drought stress (Torabi *et al*., 2015; Liang *et al*., 2003) and supported the present findings.

### Influence of Silixol on apparent infect rate (r/unit/day) and Area under disease progress curve (AUDPC) of rice genotypes under drought and irrigated conditions

### Apparent infect rate (r/unit/day)

The concentration of Silixol @ 0.6% was tested in drought and irrigated conditions against nine genotypes of rice and compared with untreated check under epiphytic conditions at different intervals (45-53), (53-63) and (63-73) days after sowing. Lowest infect rate genotypes were US-314(0.013), IIRRH-122(0.033) and IIRRH-131(0.038) treated with (T2Irrigated + 0.6% Silixol) was recorded However, (T3Drought + 0.6% Silixol) also HRI-174(0.011), 27P63 (0.021) over irrigated condition under untreated check at (63-73) days interval. Most of the

**Table 2.** Influence of silicon on morpho-physiological parameters of rice genotypes

| Treatment | Entries | Plant height (cm) | Leaf area index (LAI) | No. of Tillers / Plant | Relative water content (RWC %) | Membrane Stability Index (MSI) |
|---|---|---|---|---|---|---|
| T1(Control irrigated) | IIRRH-122 | 124 | 6.24 | 11 | 81 | 77 |
| | IIRRH-131 | 120 | 6.58 | 12 | 85 | 81 |
| | IRRH-132 | 122 | 6.26 | 13 | 87 | 82 |
| | HRI-174 | 129 | 6.64 | 12 | 86 | 82 |
| | KRH-4 | 130 | 5.32 | 11 | 81 | 77 |
| | JKRH-3333 | 122 | 6.47 | 11 | 81 | 76 |
| | US-314 | 126 | 6.69 | 12 | 87 | 83 |
| | 27P63 | 125 | 5.71 | 12 | 88 | 83 |
| | SAHABHAGIDHAN | 117 | 5.26 | 13 | 84 | 79 |
| Mean | | 124 | 6.13 | 12.0 | 84 | 80.1 |
| T2 (Irrigated + 0.6% Silixol) | IIRRH-122 | 128 | 7.16 | 12 | 84 | 79 |
| | IIRRH-131 | 124 | 7.79 | 11 | 90 | 87 |
| | IRRH-132 | 126 | 7.58 | 9 | 89 | 86 |
| | HRI-174 | 134 | 6.83 | 10 | 87 | 86 |
| | KRH-4 | 133 | 6.28 | 14 | 81 | 77 |
| | JKRH-3333 | 123 | 7.60 | 12 | 88 | 89 |
| | US-314 | 130 | 7.33 | 12 | 85 | 80 |
| | 27P63 | 127 | 6.59 | 9 | 87 | 82 |
| | SAHABHAGIDHAN | 121 | 6.39 | 12 | 85 | 80 |
| Mean | | 127 | 7.06 | 11.2 | 86 | 82.9 |
| T3(Drought + 0.6% Silixol) | IIRRH-122 | 118 | 5.31 | 11 | 80 | 77 |
| | IIRRH-131 | 114 | 6.21 | 10 | 72 | 69 |
| | IRRH-132 | 119 | 5.90 | 11 | 68 | 65 |
| | HRI-174 | 129 | 5.05 | 12 | 68 | 65 |
| | KRH-4 | 127 | 5.34 | 11 | 77 | 72 |
| | JKRH-3333 | 121 | 6.53 | 10 | 68 | 65 |
| | US-314 | 124 | 6.58 | 11 | 74 | 70 |
| | 27P63 | 121 | 5.41 | 13 | 74 | 71 |
| | SAHABHAGIDHAN | 114 | 6.63 | 12 | 73 | 70 |
| Mean | | 121 | 5.89 | 11.3 | 73 | 69.1 |
| T4 (Drought) | IIRRH-122 | 115 | 5.30 | 8 | 78 | 75 |
| | IIRRH-131 | 110 | 5.52 | 10 | 71 | 67 |
| | IRRH-132 | 112 | 5.36 | 9 | 67 | 60 |
| | HRI-174 | 126 | 5.37 | 8 | 67 | 64 |
| | KRH-4 | 121 | 4.19 | 9 | 71 | 69 |
| | JKRH-3333 | 118 | 5.27 | 9 | 66 | 63 |
| | US-314 | 119 | 5.39 | 9 | 70 | 69 |
| | 27P63 | 115 | 6.07 | 7 | 69 | 62 |
| | SAHABHAGIDHAN | 110 | 5.30 | 9 | 68 | 64 |
| Mean | | 116 | 5.31 | 8.7 | 70 | 65.7 |
| CD (0.05%) | Factor(A) | 1.598 | 0.890 | 1.178 | 2.341 | 0.772 |
| | Factor(B) | 2.149 | 0.342 | N/A | 2.204 | 1.004 |
| | Factor(B)at same level of A | N/A | 0.777 | N/A | 4.591 | 2.055 |
| | Factor(A)at same level of B | N/A | 1.093 | N/A | 4.751 | 2.039 |

genotypes lowest apparent infection rate was found Drought + 0.6% Silixol and Irrigated + 0.6% Silixol Moreover some genotypes was recorded low apparent infection rate US-314(0.031) and 27P63(0.033) at drought condition as compared to irrigated condition under untreated check. Whereas, the genotypes recorded infect rate of r/unit /day in HRI (0.114), 27P63(0.133) Shahbhagidhan (0.054) and JKRH 3333( 0.110) under drought conditions where Silixol was not applied at (63-73) days (Table 3).

Area under Disease Progress Curve (AUDPC) (Table 3) is concerned the data indicate that values are comparatively high under untreated check in comparison to Silixol treatment in both ecologies. Lowest AUDPC genotypes US-314(77.2) and 27P63 (85.1) treated with (T2 Irrigated + 0.6% Silixol) was recorded However, T3 Drought + 0.6% Silixol) also 27P63 (87.10) and Shahbhagidhan (89.17) over irrigated condition under untreated check. Among the tested genotypes the maximum values were recorded in JKRH3333(179.7), HRI174(177), KRH4 (167.8) and IRRH132(144.5) over treated with Silixol JKRH3333(109.8), HRI174 (140.2), KRH4( 120.4) and IRRH132 (107.2) respectively.

**Table 3.** Effect Silixol on Apparent infection rate, area under disease progress curve and percent disease index of rice genotypes against leaf blast

| Treatment | Entries | Apparent infection rate (r/unit/day) | | | | AUDPC | Percent Disease Index (PDI) % |
|---|---|---|---|---|---|---|---|
| | | 43-53 DAYS | 53-63 DAYS | 63-73 Days | Mean | | |
| T1 (Control: Irrigated) | IIRRH-122 | 0.065 | 0.072 | 0.085 | 0.074 | 114.4 | 18.33 |
| | IIRRH-131 | 0.054 | 0.067 | 0.093 | 0.071 | 129.6 | 15.0 |
| | IRRH-132 | 0.056 | 0.066 | 0.087 | 0.069 | 134.5 | 18.22 |
| | HRI-174 | 0.106 | 0.109 | 0.116 | 0.110 | 178.0 | 41.77 |
| | KRH-4 | 0.099 | 0.101 | 0.107 | 0.102 | 165.8 | 27.65 |
| | JKRH-3333 | 0.098 | 0.121 | 0.141 | 0.108 | 181.7 | 38.34 |
| | US-314 | 0.034 | 0.041 | 0.057 | 0.044 | 87.6 | 9.89 |
| | 27P63 | 0.051 | 0.063 | 0.072 | 0.062 | 91.5 | 6.54 |
| | SAHABHAGIDHAN | 0.058 | 0.044 | 0.041 | 0.047 | 97.0 | 8.01 |
| Mean | | 0.076 | 0.080 | 0.088 | 0.080 | 131.12 | 20.41 |
| T2 (Irrigated + 0.6% Silixol) | IIRRH-122 | 0.099 | 0.051 | 0.033 | 0.061 | 135.7 | 12.6 |
| | IIRRH-131 | 0.031 | 0.021 | 0.038 | 0.036 | 111.7 | 14.34 |
| | IRRH-132 | 0.121 | 0.061 | 0.043 | 0.075 | 147.2 | 17.43 |
| | HRI-174 | 0.102 | 0.131 | 0.108 | 0.113 | 201.0 | 39.09 |
| | KRH-4 | 0.109 | 0.123 | 0.141 | 0.124 | 150.1 | 30.44 |
| | JKRH-3333 | 0.106 | 0.117 | 0.121 | 0.119 | 177.0 | 28.77 |
| | US-314 | 0.031 | 0.021 | 0.013 | 0.021 | 77.2 | 5.65 |
| | 27P63 | 0.022 | 0.041 | 0.054 | 0.039 | 85.1 | 4.22 |
| | SAHABHAGIDHAN | 0.042 | 0.046 | 0.048 | 0.045 | 94.1 | 5.76 |
| Mean | | 0.066 | 0.068 | 0.070 | 0.070 | 128.45 | 17.58 |
| T3 (Drought + 0.6% Silixol) | IIRRH-122 | 0.055 | 0.063 | 0.067 | 0.061 | 105.7 | 13.22 |
| | IIRRH-131 | 0.058 | 0.031 | 0.038 | 0.042 | 95.8 | 16.13 |
| | IRRH-132 | 0.031 | 0.055 | 0.049 | 0.045 | 107.2 | 22.11 |
| | HRI-174 | 0.093 | 0.127 | 0.135 | 0.011 | 140.2 | 40.87 |
| | KRH-4 | 0.042 | 0.041 | 0.043 | 0.042 | 120.4 | .37.01 |
| | JKRH-3333 | 0.082 | 0.023 | 0.017 | 0.040 | 109.8 | 32.46 |
| | US-314 | 0.042 | 0.046 | 0.048 | 0.045 | 101.1 | 8.21 |
| | 27P63 | 0.028 | 0.020 | 0.017 | 0.021 | 87.10 | 4.44 |
| | SAHABHAGIDHAN | 0.023 | 0.041 | 0.054 | 0.039 | 89.17 | 7.23 |
| Mean | | 0.049 | 0.051 | 0.056 | 0.067 | 107.07 | 13.08 |
| T4 (Control: Drought) | IIRRH-122 | 0.058 | 0.065 | 0.093 | 0.072 | 112.4 | 18.33 |
| | IIRRH-131 | 0.045 | 0.049 | 0.052 | 0.048 | 122.6 | 22.02 |
| | IRRH-132 | 0.075 | 0.065 | 0.055 | 0.065 | 144.5 | 21.23 |
| | HRI-174 | 0.106 | 0.117 | 0.121 | 0.114 | 177.0 | 39.77 |
| | KRH-4 | 0.099 | 0.114 | 0.158 | 0.201 | 167.8 | 36.11 |
| | JKRH-3333 | 0.098 | 0.101 | 0.131 | 0.110 | 179.7 | 31.67 |
| | US-314 | 0.058 | 0.012 | 0.051 | 0.031 | 78.6 | 9.83 |
| | 27P63 | 0.056 | 0.027 | 0.018 | 0.033 | 93.5 | 5.41 |
| | SAHABHAGIDHAN | 0.068 | 0.054 | 0.040 | 0.054 | 102.0 | 11.01 |
| Mean | | 0.072 | 0.076 | 0.079 | 0.076 | 130.9 | 21.70 |
| CD (0.05%) | | 0.65 | 0.427 | 0.839 | 0.921 | 1.37 | 1.69 |

In regard to percent disease index (PDI) (Table 3) the data indicate that it may varied ranging from 4.22 to 41.77% in the genotypes evaluated in drought and irrigated ecology in different treatments. It is obvious from the data that maximum PDI 41.77 % was recorded in HRI 174 followed by JKRH3333 (38.44%) and KRH 4 (27.65%) in irrigated conditions in untreated check whereas, it was substantially reduced after the application of Silixol HRI (39.09%), KRH4 (30.44%) and JKRH3333 (28.77%) respectively in irrigated ecology. It is obvious from the data that PDI was comparatively low in the genotypes tested in drought conditions under untreated check and Silixol treatment over irrigated ecology.

**Effect of Silixol on yield and yield attributing traits of rice genotypes under drought and irrigated conditions**

In regard to Total dry matter (Table 3) it is clear from the data that genotypes varied drastically in the irrigated and drought condition. Total dry matter ($g/m^2$) was reduced in all nine genotypes under drought condition. It was noted that 0.6% Silixol application increased Total dry matter ($g/m^2$) in all genotypes in both the conditions (irrigated and drought). Among the tested genotypes, maximum percent increase in total dry matter ($g/m^2$) was recorded in genotypes, HRI 174 (15.1%), IIRRH 131(15.6%), IIRRH 132 (15.6%) and 27P63 (13.2%) under irrigated condition with the application of 0.6% Silixol over irrigated only . However, maximum percent increase in total dry matter ($g/m^2$) was recorded in genotypes, Sahabhagidhan (25.0%), JKRH 3333 (23.2%) and IIRRH 131(22.0%) under drought condition with the application of 0.6% Silixol over drought only.

Data presented in table (Table 3) indicate that Number of panicle/plants is one of the important trait, which was recorded at flowering stage and it was significantly affected by water regime. The mean of almost tested genotypes was reduced by >14% under drought treatment in comparison with irrigated control. The maximum percent increase in panicle number per plant was recorded in the tested genotypes, JKRH 3333 (40.0%), HRI 174 (33.3%), 27P63 (28.6%) under drought condition with the application of 0.6% Silixol in comparison with drought control.

In regard to Number of grain/panicles, data depict in (Table 3) shows that number of grains per panicle is very important yield related trait which show significant change in drought condition. Drought (T4) significantly reduced the grain number per panicle in tested genotypes in comparison with irrigated ones. Application of Silixol to drought stressed crop (T4) significantly reversed negative effects of water. Maximum grains number per panicle was recorded in genotypes, US 314 (136.0), HRI 174 (132.0), 27P63 (130.7) and JKRH 3333 (130.7) under drought condition with the application of 0.6% Silixol (T3) in the comparison with drought only.

In regard to **1000 weight**, data shows in (Table 3) indicate that the mean of 1000 grain weight was significantly affected in the drought condition in comparison with the irrigated ones. However, imposing drought stress (T4) after flowering stage the mean percent reduction in 1000 grains weight was 16.8% in comparison with irrigated treatment. Application of Silixol on drought stressed crop (T4) resulted in significantly reversed the deleterious effect of drought stress and maximum 1000 grains weight was recorded in genotypes, US 314 (21.1 g), KRH 4(21.0 g), Sahabhagidhan (20.6 g) and IRRH 132 (20.1 g) in comparison with drought only (T4).

In regard to Grain Yield (q/ha), data reveals in (Table 3) that drought stress (T4) greatly influence the grain yield in all nine genotypes in comparison with irrigated condition (T1). It was noted that the mean reduction percent in grain yield is 27% under drought stress (T4). However, Application of Silixol resulted increase in grain yield in the both treatments irrigated as well as drought condition in comparison with their control ones. Maximum grain yield was recorded in genotypes, US 314 (101 q/ha), 27P63 (99 q/ha), HRI (99 q/ha) and KRH 4 (91 q/ha) under irrigated condition with 0.6% Silixol (T2) in comparison with their control ones (T1), whereas, maximum grain yield was recorded in these genotypes, US 314 (84 q/ha), 27P63 (82 q/ha), HRI (81 q/ha) and KRH 4 (71 q/ha) under drought condition with 0.6% Silixol (T3) in comparison with their control ones (T4).

**Harvest index (HI)** is one of the most important yield traits, which was measured after harvest. In regard to HI, Data depicts in (Table 3) indicate that HI is influenced by the drought stress, whereas response of Silixol application significantly increased HI in both the treatments irrigated as well as drought stress. Among the tested genotypes the mean of HI was recorded 47% in irrigated condition

(T1) and 43% was recorded under drought stress condition (T4). It was noted that maximum percent increase in HI was recorded in genotypes, Sahabhagidhan (7.1%), IIRRH 122 (6.1%) and KRH 4 (2.5%) under drought with the application of 0.6% Silixol (T3) in comparison with the drought ones (T4), whereas, JKRH 3333 (20.0%), KRH 4 (15.9%), IIRRH 122 (15.4%) and Sahabhagidhan (14.3) genotypes showed maximum percent increase in HI under irrigated condition with the application of 0.6%

**Table 3.** Influence of silicon on yield and yield attributing traits of rice genotypes.

| Treatment | Entries | TDMg/m² | No. of Panicle/ Plant | No. of grain/ Panicle | 1000 grain wt (g) | Grain Yield (q/ha) | HI (%) |
|---|---|---|---|---|---|---|---|
| T1(Control irrigated) | IIRRH-122 | 1600 | 9 | 122.0 | 21.5 | 62 | 39 |
| | IIRRH-131 | 1457 | 9 | 128.0 | 18.5 | 73 | 49 |
| | IRRH-132 | 1496 | 10 | 123.0 | 21.1 | 71 | 49 |
| | HRI-174 | 1641 | 8 | 136.3 | 18.1 | 85 | 54 |
| | KRH-4 | 1726 | 7 | 125.7 | 22.4 | 77 | 44 |
| | JKRH-3333 | 1526 | 9 | 137.0 | 18.6 | 62 | 40 |
| | US-314 | 1615 | 11 | 143.0 | 22.7 | 88 | 55 |
| | 27P63 | 1588 | 7 | 133.0 | 17.1 | 86 | 54 |
| | SAHABHAGIDHAN | 1339 | 9 | 118.0 | 21.9 | 58 | 42 |
| Mean | | 1554 | 9 | 129.6 | 20.2 | 74 | 47 |
| T2 (Irrigated + 0.6% Silixol) | IIRRH-122 | 1665 | 10 | 128.7 | 23.3 | 75 | 45 |
| | IIRRH-131 | 1685 | 9 | 131.3 | 18.2 | 86 | 51 |
| | IRRH-132 | 1729 | 8 | 129.0 | 23.1 | 84 | 49 |
| | HRI-174 | 1906 | 9 | 139.7 | 19.8 | 99 | 52 |
| | KRH-4 | 1766 | 9 | 141.0 | 24.7 | 91 | 51 |
| | JKRH-3333 | 1580 | 8 | 132.0 | 20.2 | 75 | 48 |
| | US-314 | 1791 | 12 | 147.3 | 24.2 | 101 | 57 |
| | 27P63 | 1798 | 7 | 149.0 | 18.0 | 99 | 55 |
| | SAHABHAGIDHAN | 1480 | 9 | 121.0 | 23.2 | 70 | 48 |
| Mean | | 1629 | 9 | 135.4 | 20.9 | 87 | 49 |
| T3(Drought + 0.6% Silixol) | IIRRH-122 | 1568 | 7 | 112.0 | 19.9 | 57 | 35 |
| | IIRRH-131 | 1443 | 7 | 121.0 | 16.0 | 69 | 45 |
| | IRRH-132 | 1416 | 9 | 115.3 | 20.1 | 67 | 45 |
| | HRI-174 | 1553 | 8 | 132.0 | 16.3 | 81 | 50 |
| | KRH-4 | 1678 | 8 | 120.3 | 21.0 | 71 | 41 |
| | JKRH-3333 | 1497 | 7 | 130.7 | 17.4 | 57 | 36 |
| | US-314 | 1561 | 8 | 136.0 | 21.1 | 84 | 51 |
| | 27P63 | 1552 | 9 | 130.7 | 16.3 | 82 | 50 |
| | SAHABHAGIDHAN | 1321 | 8 | 113.0 | 20.6 | 42 | 30 |
| Mean | | 1592 | 8 | 123.4 | 20.2 | 68 | 43 |
| T1(Control drought ) | IIRRH-122 | 1311 | 8 | 110.0 | 18.7 | 42 | 33 |
| | IIRRH-131 | 1183 | 10 | 117.7 | 14.6 | 54 | 45 |
| | IRRH-132 | 1162 | 9 | 109.0 | 17.2 | 52 | 46 |
| | HRI-174 | 1287 | 6 | 128.3 | 15.8 | 65 | 51 |
| | KRH-4 | 1411 | 7 | 117.0 | 17.1 | 57 | 40 |
| | JKRH-3333 | 1215 | 5 | 123.7 | 16.1 | 44 | 36 |
| | US-314 | 1309 | 8 | 129.7 | 18.8 | 70 | 54 |
| | 27P63 | 1300 | 7 | 126.7 | 14.7 | 67 | 51 |
| | SAHABHAGIDHAN | 1057 | 8 | 100.0 | 18.4 | 30 | 28 |
| Mean | | 1248 | 8 | 118.0 | 16.8 | 54 | 43 |
| CD (0.05%) | Factor(A) | 54.572 | 0.433 | 6.362 | 0.623 | 1.84 | 0.984 |
| | Factor(B) | 51.237 | 0.981 | 6.874 | 1.492 | 3.52 | 2.827 |
| | Factor(B)at same level of A | 106.769 | 1.978 | N/A | N/A | N/A | 5.683 |
| | Factor(A)at same level of B | 110.527 | 1.898 | N/A | N/A | N/A | 5.417 |

Silixol (T2) in comparison with the irrigated only (T1).

Jawahar and Vaiyapuri (2010)Larger leaf area and high chlorophyll content might have accumulated more photosynthates and produce higher biological yield (DMP). Ishiguro (2001) and Hayasaka *et al.* (2005) Silicon would increase resistance of rice to blast disease, subsequent studies have also confirmed that the application of Silicon is an effective method to reduce and control rice blast disease. Maekawa *et al*. (2001) Resistance of rice blast was enhanced by silicon application, and that disease index for leaf and neck blast was reduced by 50.5 and 26.8% respectively. Fautex *et al*. (2006) Silicon is considered as non-essential for plant growth, but it helps in alleviation of biotic and abiotic stresses faced by the plants. Buck *et al*. (2008) studied the effect of silicon absorption through the leaves on rice blast (*Pyricularia oryzae*) control using potassium silicate ($K_2Sio_3$) in different doses (0,1,2,3,4,8 or 16 g Si L-1) and number of spraying at two solutions having different pH. Potassium silicate pulverization on the leaves did not increase Si absorption or accumulation by the plant; however, there was a reduction on blast incidence. The greatest reduction on blast incidence was observed at 4 g Si L-1, regardless of solution pH.

Yoshida *et al.* (1959) Okuda and Takahashi, (1961), and Lee *et al.* (1990). There were many reports, found that application of silicon during the reproductive growth stage is most important for plant growth and also increased the final yield of rice. Wang *et al*. (2001) Si fertilizers have been applied repeatedly to improve rice production by enhancing resistance to disease and increasing yield. Chanchareonsook *et al*. (2002) reported that application of NPK fertilizer in combination with Si increased the total number of tillers in rice. Jawahar *et al.,* 2015; Rani *et al.,* 1997; Ahmad *et al.,* 2013; and Patil *et al.* (2017). Silicon also has a major role in increasing yield attributing characters like number of spikelets, filled spikelet percentage, test weight and total grain yield in rice. The results are in conformity with the findings reported by Jawahar *et al*., 2015; Yoshida *et al.,* 1959; Okuda and Takahashi, 1961; Ma *et al.* (1989) and who stated that Silicon application may enhance the yield attributing components very effectively in rice and other crops .

## Conclusion

Treatments with (T2 irrigated+0.6 Silixol) and (T3 drought+0.6 0.6 Silixol) enhanced growth parameters and Morphophysiological and Yield Parameters under Drought stress however (T2 irrigated+0.6 Silixol) recorded minimum disease incidence. Blast disease severity may be minimized in the susceptible genotypes after the application of Silixol in both the ecology for their effective management and combat the economic losses. This is a very good alternative technology to manage the most devastating disease which may cause severe devastation to the crop and play a significant role for reducing application of fungicides for the management of disease.

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