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Effect of silicic acid for management of purple blotch on *kharif* onion (*Allium cepa*)

Rakesh Sonawane, Jitendra Dhemre, Hemant Patil and Rajendra Birade

Abstract
The field experiment was conducted three years to study the effect of silicic acid foliar application for management of purple blotch of onion in factorial randomized block design with two factors and three replications and treatments consisted of 2 seedling root dipping treatment @ 2.0 ml/l and other with tap water and five treatments of silicic acid sprays at 20, 40 and 60 days after transplanting i.e. silicic acid sprays @ 1.5 ml/L, 2.0 ml/l, 2.5 ml/l and 4 foliar sprays of Azoxystrobin @ 0.01% and control treatment. The seedling root dipping with silicic acid @ 2.0 ml/l recorded minimum percent disease index (22.58%) which was followed by seedling root dipping with tap water (23.82%). The spraying of Azoxystrobin @ 1.0 ml/l recorded minimum purple blotch disease of onion (17.99% PDI) which was at par with spraying of silicic acid @ 2.5 ml/l and @ 2.0 ml/l. In the Interaction, the seedling root dipping + Azoxystrobin @ 1.0 ml/l recorded minimum percent disease index (PDI 17.12%) which was at par spraying of silicic acid @ 2.5 ml/l and 2.0 ml/l. The seedling root dipping with silicic acid @ 2.0 ml/l recorded maximum marketable yield significantly increase in onion yield (118.46 q/ha) than without seedling root dipping treatment. Among the silicic acid spraying treatments, it is observed that the spraying of Azoxystrobin @ 1.0 ml/l recorded maximum marketable yield (128.32 q/ha) which was followed by spraying of silicic acid @ 2.5 ml/l and @ 2.0 ml/l. Interaction effect of application of seedling root dipping with silicic acid @ 2.5 ml/l in combination with Azoxystrobin @ 0.1% recorded significantly higher yield bulb followed by seedling root dipping treatments @ 2.0 ml /l and spraying of silicic acid @ 2.5 ml/l and 2.0 ml/l.

Keywords: Silicic acid, marketable bulb yield, purple blotch of onion, onion

Introduction
Onion (*Allium cepa* L.) is one of the oldest vegetables consumed worldwide plant. The onion commonly known as the bulb onion or common onion and most important commercial vegetable crops grown in India. Onion is widely used for culinary purposes and as a flavouring agent. Presently, it is available in fresh, canned pickled and frozen and dehydrated forms. Onion is cultivated round the year throughout the country. In India, onion was grown on an area of 1624 thousand hectares with production of 26641 thousand tonnes having productivity 18.1 tonnes per ha during 2020-21 (GoI, 2022). Maharashtra is leading state in area and production which having area of 450 thousand ha and production of 8047 thousand tonnes having productivity 17.88 tonnes per ha during 2018-19.

A leaf spot and blight disease of onion were first reported by Ajrekar (1923) [1] from Bombay state of India. An epidemic attack by *Alternaria porri* on onion was reported at Baringo, Kenya during the year 1961, and it causes distinct lesions on plant blades, purple or brown blotches, white, irregular spots or flecks with varying proportion (Bock 1964) [2]. Purple blotch on onion was surveyed during *kharif* 2019 and reported 27.2% to 52.8% percent disease index range in onion growing area in Nashik district of Maharashta (Sonawane *et al.*, 2020) [10]. Onion plants showing purple blotch symptoms caused by *A. porri* is a serious disease, incur to heavy yield losses in the bulb and seed crop of onion. Purple blotch of onion disease could cause heavy yield losses ranging from 2.5 to 87.8 percent during *kharif* season. (Srivastava *et al.* 1994) [11]. The lower productivity of Indian onion is primarily due to cultivation of low yield potential varieties having susceptibility to both biotic and abiotic factors. Purple blotch of onion is the most devasting factors among the biotic factors. Silicon increases the tolerance towards biotrophic, hemi-biotrophic and necrotrophic pathogens in plant species (Cooke and Leishman, 2011) [3].

Material and Methods

The field experiment was conducted at Onion Grape Research Station, Pimpalgaon Baswant, Nashik Maharashtra for three years during *kharif* season (2018-2020). The soil of experimental field is medium black soil with an excellent texture and a depth of over 60 cm as well as a homogeneous and levelled terrain. The research experiment was laid down in factorial randomized block design with three replications. The treatment comprised with total 30 treatment combinations *viz.*, Factor A: S_1: Seedling root dipping with silicic acid @ 2.0 ml/l, S_2: Seedling root dipping with tap water, Factor B: T_1: Silicic acid spray @ 1.5 ml/l, T_2: Silicic acid spray @ 2.0 ml/l, T_3: Silicic acid spray @ 2.5 ml/l, T_4: Azoxystrobin @1ml/l (4 sprays), T_5: Control. The experiments of *kharif* onion were planted on 6.8.2018, 23.07.19 and 17.07.2020 during *kharif*-18, 19 and 20 respectively. Each plot was of the size 3.0 m x 2.0 m. The variety Baswant – 780 of onion was transplanted at a spacing of 15 cm row to row and 10 cm plant to plant. According to the treatment specifications, each replication received the appropriate dose of fertilizer in the form of urea, single super phosphate and muriate of potash. It is used as a maintenance dosage. The recommended dose of fertilizer was 100 kg N: 50 kg P_2O_5: 50 kg K_2O per ha and FYM (30 t/ha) was applied during the season as per recommendations. Urea was applied in three split doses with half as basal dose and remaining quantity of N was applied in two equal splits at monthly interval after transplanting. MOP fertilizers were applied at the time of transplanting. Single super phosphate was applied as phosphorus source at the time of transplanting as per treatment details of graded P_2O_5. For foliar application, soluble silicic acid was sprayed at the concentration of 1.5 ml/l, 2 ml/l or 2.5 ml/l with a spray volume of 500 l/ha using hand sprayer at 20, 40 and 60 days after transplanting. Untreated check was sprayed with water and standard check (Azoxystrobin) was sprayed at recommended concentration of 0.1%. Disease severity observations were recorded at 10 days interval starting from 30 days after transplanting (DAT) upto 70 days, and the final observation was recorded on 90th day. The percent disease index of purple blotch of onion was recorded on 10 randomly selected plants at 10 days interval by using 0-5 scale as given by Sharma (1986) [9] as follows:

Score Disease description

1. No disease symptom,
2. A few spots covering 10 percent leaf area,
3. Several purplish brown patches covering up to 20 percent of leaf area,
4. Several patches with paler outer zone covering up to 40 percent leaf area,
5. Leaf streaks covering up to 75 percent leaf area or breaking of the leaves from center and
6. Complete drying of the leaves or breaking of leaves from center

The observations on disease severity were recorded 10 days after last fungicidal spray and the percent disease index (PDI) was computed as per the formulae given by Wheeler (1969) [12].

$$PDI = \frac{\text{Sum of individual ratings}}{\text{Total No. of leaves observed}} \times \frac{100}{\text{Max. Grade}}$$

The data for three seasons *kharif*-18, *kharif*-19 and *kharif* -20 were analysed in factorial randomized block design to determine the significance among different treatments by Indostat program.

Result and Discussion

Effect of silicic acid seedling inoculation and sprays on disease intensity of purple blotch of onion: From the pooled data of three years 2018-20 (Table 1) the percent disease index revealed that the seedling root dipping with silicic acid @ 2.0 ml/l recorded minimum percent disease index (22.58%) which was at par with the treatment S_2 – Seedling root dipping with tap water (23.82%). The treatment T_4 i.e. spraying of Azoxystrobin @ 1.0 ml/l recorded minimum purple blotch disease on onion (17.99% PDI) which was at par with T_3 i.e. spraying of silicic acid @ 2.5 ml/l (PDI 19.31%) and T_2 i.e. Silicic acid spray @ 2.0 ml/l (PDI 20.53%). Interaction effect of S_1T_4 i.e. Seedling root dipping + Azoxystrobin @ 1.0 ml/l recorded minimum percent disease index (PDI 17.12%) which was at par the treatments spraying of silicic acid @ 2.5 ml/l and 2.0 ml/l. Similar results were also reported that the least disease severity was recorded in treatment receiving two sprays of silicic acid @ 4 ml/l which was superior to 3 sprays of mancozeb @ 0.25% or other treatments (Mohammad *et al* 2020) [6]. evaluated fungicides at dither fferent concentrations for controlling purple blotch of onion during *Rabi* season 2014-2015 and 2015-2016, respectively. The foliar sprays tebuconazole 25 EC @ 0.1 percent fortnightly interval most effectively managed purple blotch of onion under field condition (Yadav *et al.* 2017) [13]. The maximum disease was controlled by tebuconazole 25 EC @ 1.0 ml/l with 56.12% PDC which was followed by Azoxystrobin 23SC @ 1ml/l with 52.04% PDC (Mandi *et al.* 2020) [5].

Effect of silicic acid seedling inoculation and sprays on bulb yield of onion: The onion yield data from (Table 2) the seedling root dipping with silicic acid @ 2.0 ml/l recorded significantly higher onion yield (118.46 q/ha) than without seedling root dipping treatment. Among the silicic acid spraying treatments, results showed that spraying of Azoxystrobin @ 1.0 ml/l recorded maximum marketable yield (128.32 q/ha) which was followed by spraying of 2.5 ml/l silicic acid (121.00 q/ha) and 2.0 ml/l silicic acid (119.15 q/ha). In the Interaction the treatment S_1T_4 recorded maximum marketable yield (129.50 q/ha) which was at par the treatments of seedling root dipping along with silicic acid spraying @ 2.5 ml/l (122.72 q/ha) and 2.0 ml/l (121.63 q/ha) and without silicic root dipping with spraying of Azoxystrobin @ 1.0 ml/l (127.15 q/ha) (Table 2). These findings were supported by Mohammad *et al.* 2020 studied that minimum disease severity was recorded in treatment of two sprays of silicic acid @ 4 ml/l than rest treatments. Further, foliar application of silicic acid @ 4.0 ml/l was significantly higher bulb yield (31.61 t/ha, 37.46 t/ha) in both varieties Arka Kalyan and Bellary Red, respectively than other rest treatments. The present findings are in agreement with the findings of earlier workers (Prakash *et al.* 2011) [8] in wetland rice, (Naik *et al.* 2021) [7] in corn and (Mandi *et al.* 2020) [5] reported that maximum onion bulb yield (145.8 q/ha) was recorded by tebuconazole 25 EC @ 1.0 ml/l which was at par with Azoxystrobin 23SC @ 1ml/l (143.3 q/ha).

Effect of silicic acid seedling inoculation and sprays on Economics of onion: Seedling root dipping with silicic acid along with spraying of silicic acid @ 2.0 ml/l and 2.5 ml/l for minimizing purple blotch disease of onion showed highest benefit cost ratio (1.59) and (1.59) with highest net monetary returns (Rs. 89800 and Rs.90945) among silicic acid root dipping and silicic acid spraying. (Table 3). The present findings are in agreement with the findings of (Yadav *et al*. 2017) [13] in onion. (Mandi *et al.* 2020) [5] recorded that Tebuconazole 25 EC @ 1 ml/l recorded the maximum B:C ratio (3.22) followed by Azoxystrobin 23 SC @ 1ml/l with B:C ration 3.14 in onion.

Table 1: Effect of silicic acid on percent disease index of purple blotch of *kharif* onion

Treatments	Percent Disease Index (PDI)			
	2018	**2019**	**2020**	**Pooled Mean**
S_1. Seedling root dipping with silicic acid@ 2.0 ml/l	19.81 (26.22)	23.56 (28.83)	24.37 (29.37)	22.58 (28.18)
S_2: Seedling root dipping with tap water	21.50 (27.43)	24.43 (29.44)	25.54 (30.18)	23.82 (29.05)
SE +	0.56	0.61	0.36	0.62
CD at 5%	1.68	1.82	1.06	1.30
T_1: Silicic acid spray @1.5 ml/l	20.45 (26.82)	24.43 (29.58)	25.51 (30.30)	23.47 (28.95)
T_2: Silicic acid spray @ 2.0 ml/l	17.97 (25.05)	22.52 (28.31)	21.12 (27.33)	20.53 (26.92)
T_3: Silicic acid spray @ 2.5 ml/l	17.63 (24.76)	20.08 (26.50)	20.24 (26.72)	19.31 (26.05)
T_4: Azoxystrobin @1ml/l	16.11 (23.61)	18.02 (25.06)	19.86 (26.44)	17.99 (25.07)
T_5: Control	31.11 (33.88)	34.94 (36.20)	38.05 (38.07)	34.70 (36.07)
SE +	0.89	0.97	0.57	0.98
CD at 5%	2.65	2.88	1.68	2.07
S_1T_1: Seedling root dipping +Silicic acid spray @ 1.5 ml	20.17 (26.58)	24.37 (29.56)	24.59 (29.66)	23.04 (28.67)
S_1T_2: Seedling root dipping+ Silicic acid spray @ 2.0 ml/l	17.04 (24.36)	22.19 (28.10)	21.21 (27.38)	20.15 (26.64)
S_1T_3: Seedling root dipping+ Silicic acid spray @ 2.5 ml/l	16.67 (23.99)	19.47 (26.16)	19.55 (26.23)	18.56 (25.51)
S_1T_4: Seedling root dipping + Azoxystrobin @ 1.0 ml/l	15.92 (23.44)	16.41 (23.84)	19.04 (25.86)	17.12 (24.43)
S_1T_5: Seedling root dipping. + Control	29.26 (32.73)	35.36 (36.48)	37.43 (37.70)	34.02 (35.65)
S_2T_1: No seedling root dipping+ Silicic acid spray @ 1.5 ml/l	20.74 (27.06)	24.50 (29.61)	26.44 (30.94)	23.89 (29.23)
S_2T_2: No seedling root dipping+Silicic acid spray @ 2.0 ml/l	18.89 (25.76)	22.84 (28.53)	21.02 (27.28)	20.92 (27.20)
S_2T_3No seedling root dipping+ Silicic acid spray @ 2.5 ml/l	18.58 (25.52)	20.68 (26.84)	20.92 (27.21)	20.06 (26.60)
S_2T_4:No seedling root dipping + Azoxystrobin @ 1.0 ml/l (Std. Check)	16.29 (32.76)	19.63 (26.28)	20.67 (27.03)	18.86 (25.72)
S_2T_5: No Seedling root dipping + Control	32.96 (35.03)	34.51 (35.93)	38.66 (38.44)	35.38 (36.49)
SE +	1.26	1.37	0.80	0.98
CD at 5%	3.75	4.07	2.38	2.92

Fig in the parenthesis are arcsine values

Table 2: Effect of silicic acid on yield of *kharif* onion

Treatments	Yield (q /ha)			
	2018	**2019**	**2020**	**Pooled Mean**
S_1. Seedling root dipping with silicic acid@ 2.0 ml/l	119.06	114.24	122.08	118.46
S_2: Seedling root dipping with tap water	114.02	108.72	116.41	113.05
SE +	2.63	4.95	4.56	1.90
CD 5%	7.84	14.72	13.56	4.06
T_1: Silicic acid spray @1.5 ml/l	115.02	102.19	110.16	109.13
T_2: Silicic acid spray @ 2.0 ml/l	122.41	112.52	122.52	119.15
T_3: Silicic acid spray @2.5 ml/l	120.46	115.02	127.53	121.00
T_4: Univ. Rec. Azoxystrobin @1ml/l	124.5	128.36	132.11	128.32
T_5: Control	100.30	99.32	103.91	101.18
SE +	4.17	7.83	7.22	3.07
CD 5%	12.39	23.27	21.43	6.42

S_1T_1: Seedling root dipping +Silicic acid spray @ 1.5 ml	117.24	104.47	115.86	112.52
S_1T_2: Seedling root dipping+ Silicic acid spray @ 2.0 ml/l	124.80	114.19	125.90	121.63
S_1T_3: Seedling root dipping+ Silicic acid spray @ 2.5 ml/l	122.55	117.80	127.80	122.72
S_1T_4: Seedling root dipping + Azoxystrobin @ 1.0 ml/l	126.50	129.47	132.53	129.50
S_1T_5: Seedling root dipping. + Control	104.19	105.30	108.91	106.13
S_2T_1: No seedling root dipping+ Silicic acid spray @ 1.5 ml/l	112.80	99.91	104.47	105.73
S_2T_2: No seedling root dipping+Silicic acid spray @ 2.0 ml/l	120.02	110.86	119.75	116.88
S_2T_3: No seedling root dipping+ Silicic acid spray @ 2.5 ml/l	118.36	112.24	127.25	119.28
S_2T_4: No seedling root dipping + Azoxystrobin @ 1.0 ml/l (Std. check)	122.50	127.25	131.69	127.15
S_2T_5: No Seedling root dipping + Control	96.41	93.35	98.91	96.22
SE +	5.90	11.08	10.21	4.35
CD 5%	17.52	32.91	30.31	9.08

Table 3: Effect of silicic acid on yield and monetary returns of *kharif* onion

Treatments	Pooled Marketable Yield (Q/ha)	Monetary Returns (Rs.)	Additional Monetary Returns (Rs.)	Treat cost	Total Cost of cultivation except Plant Protection	Net Income (Rs.)	B:C ratio
Factor A x B (Interaction) 1	2	3	4	5	6	7	8
S_1T_1: Seedling root dipping +Silicic acid spray @ 1.5 ml	112.52	225040	32600	5776	152338	72702	1.48
S_1T_2: Seedling root dipping+Silicic acid spray @ 2.0 ml/l	121.63	243260	50820	6898	153460	89800	1.59
S_1T_3: Seedling root dipping+Silicic acid spray @ 2.5 ml/l	122.72	245440	53000	7933	154495	90945	1.59
S_1T_4: Seedling root dipping + Azoxystrobin @ 1.0 ml/l	129.50	259000	66560	17460	164022	94978	1.58
S_1T_5: Seedling root dipping. + Control	106.13	212260	19820	710	147272	64988	1.44
S_2T_1: No Seedling root dipping+ Silicic acid spray@ 1.5 ml/l	105.73	211460	19020	5066	151628	59832	1.39
S_2T_2: No Seedling root dipping + Silicic acid spray @ 2.0 ml/l	116.88	233760	41320	6188	152750	81010	1.53
S_2T_3: N0 Seedling root dipping +Silicic acid spray@ 2.5 ml/l	119.28	238560	46120	7223	153785	84775	1.55
S_2T_4: No Seedling root dipping + Azoxystrobin @ 1.0 ml/l	127.15	254300	61860	16750	163312	90988	1.56
S_2T_5: No Seedling root dipping + Control	96.22	192440	-	0	146562	45878	1.31

Onion Rate: Rs 2000/- Qtl, Azoxystrobin: Rs 4300/L, Silicic acid: Rs. 1150/- / L, Labour charges: Rs 300/- per day, sticker Rs 600/- per lit

Conclusion

It may be concluded that reduction in purple blotch disease and increase in yield of onion might be due to different mechanisms of action of silicic acid which needs further investigation. However, it is evident from the present study that the seedling root dipping with silicic acid @ 2.0 ml/L at the time of transplanting and spraying of silicic acid @ 2.0 ml/L after 20, 40 and 60 days after onion transplanting helps in reducing the purple blotch disease severity in onion and hence could be used as one of the eco-friendly strategies in disease management.

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