Harnessing natural arsenal for effective management of jassid on brinjal

[*Solenum melongena* L.]

ABSTRACT

In brinjal ecosystem, jassid cause enormous damage to brinjal. Hence, investigation on Harnessing natural arsenal for effective management of jassid on brinjal was carried out during 2022-23 and 2023-24 at S. D. Agriculture University, Sardarkrushinagar, Gujarat, India. The most effective treatment was Azadirachtin 1500 ppm (0.0006%), reducing jassid population to 1.44 jassids/leaf, followed by *Lecanicillium lecanii* 1.15 WP (1×10^8 cfu/g) at 0.0046 per cent, which recorded 1.82 jassids/leaf. Other treatments, such as NSKE at 5 per cent (2.14 jassids/leaf) and NSKE + Cow urine (2.36 jassids/leaf), also showed good results. Dashparni ark (2.55 jassids/leaf) and Neemastra (2.85 jassids/leaf) were moderately effective, while Brahmastra and Panchparni ark were less effective, both recording 3.20 jassids/leaf. The study highlights the potential of Azadirachtin and *Lecanicillium lecanii* as sustainable, effective treatments for jassid management in brinjal.

Keywords: Biopesticide, *Lecanicillum lecanii*, Azadirachtin, Jassids, Brinjal and *Solenum melongena* L.

BACKGROUND

Brinjal is a paramount vegetable crop of the subtropics and tropics with fuel, nutritional and ayurvedic medicinal value. In India, it is cultivated in almost all states of India (Sathe *et al.*, 2016). India ranked 2nd in the production of brinjal in the world after China. (Anon., 2022[a]). Though brinjal is a warm-season crop, it is being grown throughout the year under irrigated conditions. In India, it is grown over an area of 753 thousand hectares in India, with a production of 13023 thousand MT and a productivity of 17.53 MT per hectare (Anon., 2022[b]). There have been reports of 140 different types of insect pests attacking brinjal crops (Dwivedi *et al.*, 2014).

Jassids, adults and nymphs suck the sap from the underside of leaves and inject their toxic saliva into the tissue causing toxemia. Damage causes the affected leaf to turn yellowish and begin curling inward from the margins (Das and Islam, 2014; Bharati and Shetgar, 2015; Kumar et al., 2017; Chand et al., 2024). The plant becomes stunted in growth and bears few buds and flowers, thereby the yield is adversely affected. Jassid also transmits mycoplasmal disease known as ‘little leaf’.

MATERIAL AND METHODS

Biopesticides are increasingly recognized for their efficacy and safety in managing jassid on brinjal. Biopesticides derived from natural sources have shown varying degrees of efficacy against jassids. Hence, an experiment on the bio-efficacy of different biopesticides against jassid on brinjal was carried out.

Biopesticide treatments for pest management include the following formulations: (T_1) Neem seed kernel extract (NSKE) @ 5 per cent, (T_2) NSKE + Cow urine @ 5 + 10 per cent, (T_3) *Panchparni ark* @ 10 per cent, (T_4) *Agniastra* @ 10 per cent, (T_5) *Neemastra* @ 10 per cent, (T_6) *Brahmastra* @ 10 per cent, (T_7) *Dashparni ark* @ 10 per cent, (T_8) Azadirachtin 1500 ppm @ 0.0006 per cent, (T_9) *Lecanicillum lecanii* 1.15 WP (1×10^8 cfu/g) @ 0.0046 per cent and (T_{10}) Untreated control.

For the purpose of recording observation, five plants were randomly selected from each net plot. From each selected plant, three brinjal leaves one each from top, middle and bottom region were carefully examined for the presence of adult of whitefly and nymph and adult of aphid and jassid. Observations were recorded at one day before and on 3rd, 6th and 9th day after each spray. From this the average population per leaf was work out.

RESULTS AND DISCUSSION

The mean data of pooled over spray during 2022-23 presented in Table 1 revealed that the lowest jassid population was observed in azadirachtin 1500 ppm @ 0.0006 per cent which found 1.54 jassids per leaf and it was followed by *L. lecanii* 1.15 WP (1×10^8 cfu/g) @ 0.0046 per cent (1.94 jassids/leaf). These two treatments were found significantly superior over rest of the treatments. The treatment of NSKE @ 5 per cent recorded 2.28 jassids per leaf, which was at par with NSKE + Cow urine @ 5 + 10 per cent (2.52 jassids/leaf) found significantly lower population of jassids during 2022-23. The next effective treatments were *Dashparni ark* @ 10 per cent and *Neemastra* @ 10 per cent as they recorded 2.71 and 2.96 jassids per leaf, respectively. While, the plots treated with *Panchparni ark* @ 10 per cent (3.48 jassids/leaf) found maximum population of jassid and it was at par with *Brahmastra* @ 10 per cent (3.26 jassids/leaf) and *Agniastra* @ 10 per cent (3.13 jassids/leaf). The untreated control plots recorded 5.46 jassids per leaf.

It can be seen from data of pooled over spray of first and second spray presented in Table 2 indicated that the lowest jassid population was observed in azadirachtin 1500 ppm @ 0.0006 per cent which found 1.35 jassids per leaf and it was followed by *L. lecanii* 1.15 WP (1×10^8 cfu/g) @ 0.0046 per cent (1.70 jassids/leaf). These two treatments were found significantly superior over rest of the treatments. The treatments NSKE @ 5 per cent of recorded 2.01 jassids per leaf, which was at par with NSKE + Cow urine @ 5 + 10 per cent (2.19 jassids/leaf) found significantly lower population of jassids. The next effective treatments were *Dashparni ark* @ 10 per cent and *Agniastra* @ 10 per cent as they recorded

2.39 and 2.53 jassids per leaf, respectively. While, the plots treated with *Brahmastra* @ 10 per cent (3.14 jassids/leaf) found maximum population of jassid and it was at par with *Panchparni ark* @ 10 per cent (2.93 jassids/leaf) and *Neemastra* @ 10 per cent (2.75 jassids/leaf). The untreated control plots recorded 5.33 jassids per leaf.

The data of pooled over years (2022-23 and 2023-24) presented in Table 1 and Fig 1 showed that the lowest jassid population was recorded from the plots treated with azadirachtin 1500 ppm @ 0.0006 per cent (1.44 jassids/leaf) and it was followed by *L. lecanii* 1.15 WP (1×10^8 cfu/g) @ 0.0046 per cent (1.82 jassids/leaf) in the pooled over the year (2022-23 and 2023-24). These treatments were significantly superior to remaining treatments including untreated control (5.40 jassids/leaf). Treatments next in order were NSKE @ 5 per cent (2.14 jassids/leaf) and NSKE + Cow urine @ 5 + 10 per cent (2.36 jassids/leaf). The plots treated with *Dashparni ark* @ 10 per cent recorded 2.55 jassids per leaf and it was followed by *Neemastra* @ 10 per cent (2.85 jassids/leaf) which was at par with *Agniastra* @ 10 per cent (2.86 jassids/leaf) found mediocre against jassid. The treatments of *Brahmastra* @ 10 per cent and *Panchparni ark* @ 10 per cent were less effective against jassid population as they recorded 3.20 and 3.20 jassids per leaf, respectively.

The present findings are in agreement with the findings of several workers. Vu *et al.* (2007) studied twelve strains of entomopathogenic fungi among tested entomopathogenic fungi, *L. lecanii* 41185 showed the highest virulence at 25°C temperature and 75 per cent relative humidity (RH) for both *M. persicae* and *A. gossypii*, were nearly 100 per cent.

Karkar *et al.* (2014) reported that lowest population of jassids (4.79/leaf) in the treatment of *M. anisopliae* @ 40 g/l followed by *L. lecanii* @ 40 g/l (4.98/ leaf).

Halder *et al.* (2023) studied that on brinjal plant various entomopathogenic fungi (EPF) *viz.*, *M. anisopliae* 1.15 WP, *B. bassiana* 1.15 WP and *L. lecanii* 1.15 WP were evaluated individually and their 1:1 mixture with botanicals like neem seed oil against these nefarious sucking pests and juxtaposing to commonly used chemical insecticide Imidacloprid 17.8% SL as check treatment under open field conditions during 2020 and 2021. Amongst the three EPF tested, minimum jassids (1.77, 2.33/leaf) and whiteflies (1.41, 1.63/leaf) population were observed in experimental plots sprayed with *L. lecanii* 1.15 WP during both the years, respectively. Half of the approved doses of *L. lecanii* 1.15 WP and neem seed oil combination registered the lowest jassids and whiteflies population along with highest reduction over control which was at par with Imidacloprid 17.8 SL. Thus, the present finding on impact of biopesticides on jassid of brinjal are similar with finding of above workers.

CONCLUSION

The study elucidated that Azadirachtin 1500 ppm (0.0006%) constituted the most potent intervention for the management of jassid populations on brinjal, diminishing infestations to a mere 1.44 jassids per leaf. *Lecanicillium lecanii* 1.15 WP (0.0046%) also exhibited commendable efficacy, with a reduction to 1.82 jassids per leaf. Treatments such as NSKE, NSKE in conjunction with cow urine, Dashparni ark and Neemastra manifested moderate suppressive effects, whereas Brahmastra and Panchparni ark demonstrated relatively limited efficacy. In conclusion, Azadirachtin and *Lecanicillium lecanii* emerged as promising, sustainable biopesticidal solutions, offering considerable potential for integrated pest management strategies.

Table 1: Bio-efficacy of biopesticides against jassid on brinjal during 2022-23

Tr. No.	Treatments	Conc. (%)	Jassid/leaf													
			DBS	First spray			Pooled over period	Second spray			Pooled over period	Third spray			Pooled over period	Pooled over spray
				3 DAS	6 DAS	9 DAS		3 DAS	6 DAS	9 DAS		3 DAS	6 DAS	9 DAS		
T_1	NSKE	5	2.06^{a} (3.76)	1.82^{b} (2.80)	1.77^{bc} (2.62)	1.79^{bc} (2.71)	1.79^{def} (2.71)	1.74^{bcd} (2.53)	1.69^{cde} (2.35)	1.70^{cde} (2.40)	1.71^{ef} (2.43)	1.54^{cd} (1.88)	1.46^{cd} (1.62)	1.50^{cde} (1.76)	1.50^{d} (1.75)	1.67^{f} (2.28)
T_2	NSKE + Cow urine	5 + 10	1.96^{a} (3.33)	1.89^{b} (3.09)	1.82^{bc} (2.80)	1.86^{bc} (2.95)	1.86^{cde} (2.95)	1.81^{bcd} (2.78)	1.74^{bcd} (2.52)	1.77^{bcd} (2.64)	1.77^{de} (2.65)	1.66^{bcd} (2.24)	1.52^{bcd} (1.80)	1.57^{bcd} (1.98)	1.58^{d} (2.01)	1.74^{ef} (2.52)
T_3	*Panchparni ark*	10	2.22^{a} (4.45)	2.06^{ab} (3.72)	2.04^{ab} (3.67)	2.04^{ab} (3.67)	2.05^{b} (3.70)	2.00^{b} (3.51)	2.05^{ab} (3.68)	2.08^{b} (3.82)	2.04^{b} (3.67)	1.96^{b} (3.33)	1.85^{b} (2.91)	1.88^{b} (3.03)	1.89^{b} (3.09)	2.00^{b} (3.48)
T_4	*Agniastra*	10	2.12^{a} (4.01)	2.01^{ab} (3.56)	1.99^{b} (3.47)	2.00^{b} (3.50)	2.00^{bc} (3.51)	1.95^{bc} (3.31)	1.90^{bc} (3.11)	1.93^{bc} (3.21)	1.93^{ab} (3.23)	1.83^{bc} (2.86)	1.75^{bc} (2.56)	1.79^{bc} (2.69)	1.79^{b} (2.70)	1.91^{bc} (3.13)
T_5	*Neemastra*	10	2.05^{a} (3.72)	2.00^{ab} (3.51)	1.94^{b} (3.25)	1.96^{bc} (3.33)	1.97^{bc} (3.37)	1.89^{bc} (3.07)	1.84^{bcd} (2.88)	1.87^{bcd} (3.01)	1.87^{cd} (2.99)	1.78^{bc} (2.65)	1.70^{bc} (2.39)	1.76^{bc} (2.58)	1.74^{bc} (2.54)	1.86^{cd} (2.96)
T_6	*Brahmastra*	10	2.15^{a} (4.11)	2.04^{ab} (3.68)	2.01^{b} (3.53)	2.03^{b} (3.61)	2.03^{b} (3.61)	1.99^{b} (3.44)	1.93^{bc} (3.24)	1.96^{bc} (3.35)	1.96^{bc} (3.34)	1.91^{b} (3.15)	1.76^{bc} (2.59)	1.81^{bc} (2.78)	1.83^{b} (2.84)	1.94^{bc} (3.26)
T_7	*Dashparni ark*	10	2.03^{a} (3.60)	1.96^{b} (3.35)	1.90^{bc} (3.09)	1.92^{bc} (3.20)	1.93^{bcd} (3.21)	1.86^{bc} (2.96)	1.80^{bcd} (2.76)	1.82^{bcd} (2.80)	1.82^{cde} (2.81)	1.69^{bcd} (2.35)	1.56^{cde} (1.93)	1.62^{bcd} (2.11)	1.62^{cd} (2.13)	1.79^{de} (2.71)
T_8	Azadirachtin 1500 ppm	0.0006	2.16^{a} (4.16)	1.70^{b} (2.40)	1.60^{c} (2.06)	1.64^{c} (2.19)	1.65^{f} (2.21)	1.54^{d} (1.87)	1.39^{e} (1.44)	1.42^{e} (1.50)	1.45^{g} (1.60)	1.22^{e} (1.00)	1.14^{e} (0.81)	1.20^{e} (0.94)	1.19^{e} (0.91)	1.43^{h} (1.54)
T_9	*Lecanicillum lecanii* 1.15 WP (1×10^{8} cfu/g)	0.0046	2.11^{a} (3.95)	1.8^{b} (2.73)	1.72^{bc} (2.46)	1.76^{bc} (2.61)	1.76^{ef} (2.60)	1.66^{cd} (2.26)	1.54^{de} (1.86)	1.59^{de} (2.02)	1.60^{f} (2.05)	1.41^{de} (1.49)	1.26^{de} (1.08)	1.31^{de} (1.22)	1.33^{e} (1.26)	1.56^{g} (1.94)
T_{10}	Untreated control	-	2.12^{a} (4.01)	2.37^{a} (5.12)	2.36^{a} (5.09)	2.40^{a} (5.26)	2.38^{a} (5.15)	2.41^{a} (5.32)	2.43^{a} (5.42)	2.49^{a} (5.68)	2.44^{a} (5.47)	2.46^{a} (5.54)	2.51^{a} (5.78)	2.55^{a} (5.98)	2.50^{a} (5.77)	2.44^{a} (5.46)
S.Em. ±		T	0.13	0.10	0.10	0.10	0.050	0.09	0.10	0.10	0.049	0.10	0.10	0.10	0.053	0.032
		P	-	-	-	-	0.032	-	-	-	0.031	-	-	-	0.033	0.018
		S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.018
		T × P	-	-	-	-	0.100	-	-	-	0.097	-	-	-	0.104	0.056
		S × P	-	-	-	-	-	-	-	-	-	-	-	-	-	0.031
		S × T	-	-	-	-	-	-	-	-	-	-	-	-	-	0.056
		S × P × T	-	-	-	-	-	-	-	-	-	-	-	-	-	0.097
C.D. at 5%		T	N.S.	0.29	0.29	0.30	0.14	0.28	0.29	0.30	0.14	0.31	0.31	0.31	0.15	0.090
C.V.%			10.46	8.64	8.95	9.14	8.91	8.52	9.22	9.30	9.01	10.25	10.81	10.75	10.6	9.18

Figures in parentheses are retransformed values of $\sqrt{X+0.5}$ transformation
Treatment means with the letter(s) in common are not significant by DNMRT at 5 per cent level of significance

Table 2: Bio-efficacy of biopesticides against jassid on brinjal during 2023-24

Tr. No.	Treatments	Conc. (%)	Jassid/leaf													
			DBS	First spray			Pooled over period	Second spray			Pooled over period	Third spray			Pooled over period	Pooled over spray
				3 DAS	6 DAS	9 DAS		3 DAS	6 DAS	9 DAS		3 DAS	6 DAS	9 DAS		
T_1	NSKE	5	2.12^{a} (3.98)	1.74^{bc} (2.54)	1.70^{bcd} (2.37)	1.73^{bcd} (2.48)	1.72^{def} (2.46)	1.55^{cd} (1.91)	1.62^{bcd} (2.13)	1.68^{bc} (2.33)	1.62^{ef} (2.11)	1.45^{cde} (1.60)	1.38^{cd} (1.40)	1.41^{cde} (1.49)	1.41^{e} (1.49)	1.58^{g} (2.01)
T_2	NSKE + Cow urine	5 + 10	2.04^{a} (3.64)	1.78^{bc} (2.67)	1.74^{bcd} (2.53)	1.76^{bcd} (2.61)	1.76^{cde} (2.60)	1.73^{bcd} (2.50)	1.67^{bc} (2.30)	1.71^{bc} (2.44)	1.71^{def} (2.41)	1.50^{cd} (1.75)	1.41^{cd} (1.50)	1.45^{cd} (1.61)	1.46^{e} (1.62)	1.64^{fg} (2.19)
T_3	*Panchparni ark*	10	1.99^{a} (3.46)	1.96^{b} (3.35)	1.90^{bc} (3.11)	1.93^{bc} (3.23)	1.93^{b} (3.23)	1.91^{b} (3.14)	1.87^{b} (3.02)	1.89^{b} (3.07)	1.89^{bc} (3.07)	1.78^{bc} (2.68)	1.69^{bc} (2.36)	1.74^{bc} (2.53)	1.74^{bc} (2.52)	1.85^{bc} (2.93)
T_4	*Agniastra*	10	2.07^{a} (3.78)	1.90^{bc} (3.12)	1.86^{bcd} (2.97)	1.89^{bcd} (3.06)	1.88^{bc} (3.05)	1.84^{bc} (2.87)	1.76^{bc} (2.61)	1.79^{b} (2.69)	1.80^{bcd} (2.73)	1.64^{bc} (2.20)	1.54^{bc} (1.86)	1.63^{bc} (2.17)	1.61^{cd} (2.08)	1.74^{de} (2.53)
T_5	*Neemastra*	10	2.11^{a} (3.97)	1.92^{bc} (3.19)	1.89^{bc} (3.06)	1.91^{bcd} (3.13)	1.91^{b} (3.13)	1.85^{bc} (2.94)	1.81^{bc} (2.78)	1.85^{b} (2.92)	1.84^{bcd} (2.88)	1.71^{bc} (2.41)	1.61^{bc} (2.08)	1.68^{bc} (2.32)	1.66^{cd} (2.27)	1.80^{cd} (2.75)
T_6	*Brahmastra*	10	2.11^{a} (3.96)	1.99^{ab} (3.45)	1.95^{ab} (3.30)	1.98^{ab} (3.43)	1.97^{b} (3.40)	1.97^{b} (3.36)	1.92^{b} (3.17)	1.95^{b} (3.30)	1.94^{b} (3.28)	1.85^{b} (2.92)	1.75^{b} (2.57)	1.82^{b} (2.80)	1.81^{b} (2.76)	1.91^{b} (3.14)
T_7	*Dashparni ark*	10	2.02^{a} (3.59)	1.84^{bc} (2.89)	1.81^{bcd} (2.77)	1.82^{bcd} (2.80)	1.82^{bcd} (2.82)	1.77^{bcd} (2.63)	1.72^{bc} (2.45)	1.75^{b} (2.56)	1.75^{cde} (2.55)	1.57^{bcd} (1.95)	1.49^{bcd} (1.72)	1.53^{bcd} (1.84)	1.53^{de} (1.84)	1.70^{ef} (2.39)
T_8	Azadirachtin 1500 ppm	0.0006	2.07^{a} (3.80)	1.64^{c} (2.19)	1.54^{d} (1.87)	1.58^{d} (1.99)	1.59^{f} (2.02)	1.48^{d} (1.69)	1.31^{d} (1.21)	1.39^{b} (1.42)	1.39^{g} (1.43)	1.16^{e} (0.84)	1.05^{e} (0.59)	1.11^{e} (0.72)	1.10^{f} (0.72)	1.36^{i} (1.35)
T_9	*Lecanicillum lecanii* 1.15 WP (1×10^{8} cfu/g)	0.0046	2.00^{a} (3.49)	1.70^{bc} (2.39)	1.60^{cd} (2.06)	1.63^{cd} (2.17)	1.65^{ef} (2.21)	1.70^{bcd} (2.38)	1.50^{cd} (1.75)	1.68^{c} (2.32)	1.57^{f} (1.95)	1.28^{de} (1.13)	1.18^{de} (0.90)	1.26^{de} (1.08)	1.24^{f} (1.04)	1.48^{h} (1.70)
T_{10}	Untreated control	-	2.12^{a} (3.98)	2.30^{a} (4.77)	2.32^{a} (4.88)	2.35^{a} (5.01)	2.32^{a} (4.89)	2.38^{a} (5.14)	2.42^{a} (5.35)	2.46^{a} (5.57)	2.42^{a} (5.35)	2.48^{a} (5.64)	2.50^{a} (5.75)	2.53^{a} (5.89)	2.50^{a} (5.76)	2.41^{a} (5.33)
S.Em. ±		T	0.13	0.09	0.10	0.10	0.048	0.10	0.10	0.10	0.051	0.10	0.10	0.10	0.049	0.031
		P	-	-	-	-	0.030	-	-	-	0.031	-	-	-	0.031	0.017
		S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.017
		T × P	-	-	-	-	0.095	-	-	-	0.098	-	-	-	0.097	0.054
		S × P	-	-	-	-	-	-	-	-	-	-	-	-	-	0.030
		S × T	-	-	-	-	-	-	-	-	-	-	-	-	-	0.054
		S × P × T	-	-	-	-	-	-	-	-	-	-	-	-	-	0.094
C.D. at 5%		T	N.S.	0.26	0.29	0.30	0.14	0.29	0.30	0.29	0.14	0.28	0.29	0.29	0.14	0.087
C.V.%			10.46	8.07	9.23	9.39	8.91	9.40	10.00	9.20	9.52	10.09	10.87	10.32	10.42	9.27

Figures in parentheses are retransformed values of $\sqrt{X+0.5}$ transformation

Treatment means with the letter(s) in common are not significant by DNMRT at 5 per cent level of significance

Table 3: Bio-efficacy of biopesticides against jassid on brinjal (Pooled)

Tr. No.	Treatments	Concentration (%)	Jassid/leaf		
			2022-23	2023-24	Pooled over year
T_1	NSKE	5	1.67^{f} (2.28)	1.58^{g} (2.01)	1.63^{e} (2.14)
T_2	NSKE + Cow urine	5 + 10	1.74^{ef} (2.52)	1.64^{fg} (2.19)	1.69^{de} (2.36)
T_3	*Panchparni ark*	10	2.00^{b} (3.48)	1.85^{bc} (2.93)	1.92^{b} (3.20)
T_4	*Agniastra*	10	1.91^{bc} (3.13)	1.74^{de} (2.53)	1.83^{c} (2.86)
T_5	*Neemastra*	10	1.86^{cd} (2.96)	1.80^{cd} (2.75)	1.83^{c} (2.85)
T_6	*Brahmastra*	10	1.94^{bc} (3.26)	1.91^{b} (3.14)	1.92^{b} (3.20)
T_7	*Dashparni ark*	10	1.79^{de} (2.71)	1.70^{ef} (2.39)	1.75^{d} (2.55)
T_8	Azadirachtin 1500 ppm	0.0006	1.43^{h} (1.54)	1.36^{i} (1.35)	1.39^{g} (1.44)
T_9	*Lecanicillum lecanii* 1.15 WP (1×10^{8} cfu/g)	0.0046	1.56^{g} (1.94)	1.48^{h} (1.70)	1.52^{f} (1.82)
T_{10}	Untreated control	-	2.44^{a} (5.46)	2.41^{a} (5.33)	2.43^{a} (5.40)
S.Em. ±		T	0.032	0.031	0.022
		P	0.018	0.017	0.012
		S	0.018	0.017	0.012
		Y	-	-	0.010
		T × P	0.056	0.054	0.039
		S × P	0.031	0.030	0.021
		S × T	0.056	0.054	0.039
		Y × P	-	-	0.017
		Y × T	-	-	0.032
		Y × S	-	-	0.017
		T × S × P	0.097	0.094	0.067
		Y × S × T	-	-	0.055
		Y × S × P	-	-	0.030
		Y × P × T	-	-	0.055
		Y × S × P × T	-	-	0.095
C.D. at 5%		T	0.090	0.087	0.063
		Y × T	-	-	NS
C.V.%			9.18	9.27	9.23

Figures in parentheses are retransformed values of $\sqrt{X+0.5}$ transformation
Treatment means with the letter(s) in common are not significant by DNMRT at 5 per cent level of significance

DECLARATIONS

Ethics approval and consent to participate

Not applicable.

Consent for publication

The authors agreed to publish this paper. The data have not been published partially or completely in any other journal.

Availability of data and materials

All data generated and analyzed for the current study are presented in this manuscript, and the corresponding author has no objection to the availability of data and materials.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

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