__Original Research Article__

A comprehensive approach to manage *Eriophyes prosopidis* mite induce flower galls in *Prosopis cineraria* (L.) Druce

Abstract: The Khejri tree, or *Prosopis cineraria*, is a vital resource in the Thar Desert. Sangri, the name of its pods, is the key ingredient in the Rajasthani vegetable dishes Panchkutta and Trikuta. There is severe gall formation and significant pod reduction a caused by the eriophyid mite *Eriophyes prosopidis* in *P. cineraria*. To develop an effective management strategy for the khejri inflorescence gall, field trials were conducted in the current study to test several botanicals, entomopathogens, and chemicals in addition to mechanical management techniques.

Comment [MP1]: Correct the sentense

Comment [MP2]: Specify comprehesive result in short here in abstract

Keywords: *Prosopis cineraria*, *Eriophyes prosopidis*, botanicals, entomopathogens and chemicals

1. Introduction

Prosopis cineraria (Khejri), a common and naturally occurring tree, is a leguminous multipurpose tree. It is sometimes referred to as the "Wonder tree" of the Thar Desert or the "Golden Tree." It is crucial to the socioeconomic advancement of farmers in India's desert regions. Khejri plays a significant function as a drought-resistant food in desert regions where cultivating vegetables is challenging [37]. It is indigenous to India, and in certain places it is even regarded as a tree of worship [14][15]. In the dry regions of western Rajasthan, *P.* cineraria (Khejri) pods are the most prized food and top feed agro-forestry species. It offers green leaves known as loong to the livestock in the desert which is considered extremely palatable and nourishing forage feed[2][3][5]. The indigenous populace uses green (sangri) and dried pods (kho-kha) as famine food [17]. In agricultural landscapes, tree development typically has a negative impact on crop productivity and vegetative biomass under and around the tree. However, beneath its shade, kheiri is believed to improve crop or vegetation productivity. Sangri, has a variety of medical applications,

Fig 1: Flower galls infested khejri

Comment [MP3]: Whether it can be used as food? If not Plz correct the sentense accordingly

Comment [MP4]: development of other trees including the treatment of pain, excessive cholesterol, diabetes, anemia, renal, and hepatic conditions, chronic diseases including cancer and atherosclerosis [9].

Recent severe insect and disease attacks have drastically decreased the ability of *P. cineraria* to produce pods. According to [28] [40] bruchids and flower galls are to blame for the decrease in seed and pod yield. Usually in healthy trees, 4-5 kg of pods per plant can be obtained but due to flower gall formation pod yield is immensely decreased [27].

According to [1][33][35] plant galls are irregular growths brought on by nematodes, fungi, bacteria, mites, insects, etc. stimulating plant cells. Galls can develop on the roots, in the lamina and petioles of leaves, twigs, buds, or flowers. Each form of gall-producer is unique to a single plant species. The gall is a particular instance of a plant-pest connection that results in negative effects including hypertrophies and tumorous (neoplasmic) outgrowths as well as positive effects for the plants by assisting bacteria, actinomycetes, and blue-green algae in fixing nitrogen. [29] reported that in *P. cineraria*, galls inhibit vegetative growth and seed production. *Prosopis* sp. are just a few of the host plants that are seriously harmed by damage from plant galls [18] [19] [23] [28] [5]. Four different forms of galls have been described in *P. cineraria* [28] [29] [19].

In the experimental field between 1999 and 2000, [19] evaluated the seasonal fluctuation in the population of *Eriophyes prosopidis* Saxena, which causes inflorescence gall in young and mature tree stands of *P. cineraria*. [6] discovered the floral organ implicated in gall development and its effects on pod development in *P. cineraria* trees. According to [18] [19] gall formation was higher in unlopped trees, resulting in low pod production in comparison to lopped trees. In fact, these gall-forming insects are attracted to flowers during flowering season and inhibit the production of pods and seeds by converting ovarian tissues into galls. According to [32] [16] when an insect interacts with its host tissues an intricate material of nucleic acid and protein is formed which helps in the development of galls. Additionally, the insect secretions and actively expanding ovarian cells in *P. cineraria* create aberrant growths in the form of galls.

The *Prosopis* tree's stem, branches, rachis, leaflets, and flowers are all affected by galls. Galls of the khejri inflorescence is caused by *E. prosopidis*, an eriophyid mite and are a frequent occurrence in arid regions that prevent flowers from setting and reduce pod yield (Fig 1). Damage from flower galls lowers the tree's aesthetic appeal but also lowers the yield of pods, which raises the cost per kilogram of pods. When reviewing the aforementioned studies undertaken by various researchers, an integrated management strategy to address the flower gall of Khejri has been identified to be lacking. In order to assess a competent management plan against the flower gall inducer, the current study was carried out.

2. Materials and Methods

In order to assess the efficiency of different management measures against *Eriophyes prosopidis*, the cause of the floral galls in the Khejri, under field trial at five different locations in Rajasthan viz., Plaodi, Lohawat, Osia, Baori and Pipar were conducted. Each treatment was replicated thrice and data was recorded on average number of flower galls and pods formed on the marked branches of tree post treatment. The field trial was conducted from 2018-2022. First spray was done at the budding stage (of flowering) and the second after 15 days on the marked trees. Following measures were adopted:

1) Mechanical measures: The removal of the dried khejri flower galls' fallen on ground.

2) Lopping of trees: An experiment involving lopping was carried out in the months of October-December at intervals of one year, two years, and three years. The level of incidence of flower gall was assessed in succeeding seasons.

3) Chemical, botanical and Entomopathogens: Effects of different botanicals entomopathogens and pesticides was recorded viz., *Beauveria bassiana, Hirsutella Thompsonii, Paecilomyces fumosoroseus, Metarhizium anisopliae* and *Lecanicillium lecanii* (entomopathogens); *Putranjiva roxburgii, Balanites aegyptiaca, Calotropis procera, Murraya koenigii, Eucalyptus, Annona squamosa,* Javik kheti Azadirachtin (botanicals); Abamection, Imidacloprid, Diafenthiuron 25% WW + Pyriproxyfen 5% WW, Spiromesifen, chlorfenapy (different insecticides) and control.

3. Results

A) Removal of fallen dried flower galls of khejri:

Eriophyes prosopidis causes flower gall and leaf gall of the khejri. Mites puncture the plant's outermost cells and cause the unopened flower bud to turn into a gall. Additionally, it was discovered that the eryiophid mites responsible for floral gall of khejri emerge on the outer surface of the mature galls and resemble like rust and massive colonies of the mite's mature and juvenile stages can be seen under a microscope. After the dried mature gall falls to the ground, these mites look for shelter close to the tree, in nooks and crannies, underneath the bark, and in other locations. They then infest freshly developed buds in the next season from February to

Comment [MP5]: Any previous work is carried on regarding its management. If it is available, please cite that. Otherwise mention it as scanty information is available or this is first attempt to devolop such approach

Comment [MP6]: How many times and at what intervals? The collected materials are destroyed or not?

Comment [MP7]: Mention in details regarding how many tress are considered for each looping methods and replications. Clear the confusion regarding intervals of 1, 2, 3 years. How many loopings for each treatments given that should be clearly mentioned. Otherwise it is not easy to understand for future use by other author if require

Comment [MP8]: Check the spelling

Comment [MP9]: Trade name or source of supply to be mentioned in MM or in tables of treatments. Rewrite this part in very simple form for better understanding

Comment [MP10]: Need to give emphasis on outputs only from the trial. Need not to mention general theoritical knowledge here in result parts. Some statements are related to material and methodology which are not fit here as result. Result should be presented with sufficient data.

Comment [MP11]: How much damage is reduced due to such practice, that is not mentioned here

March. Therefore the dried mature galls fallen on the ground were collected and removed as shown in the Fig 2.

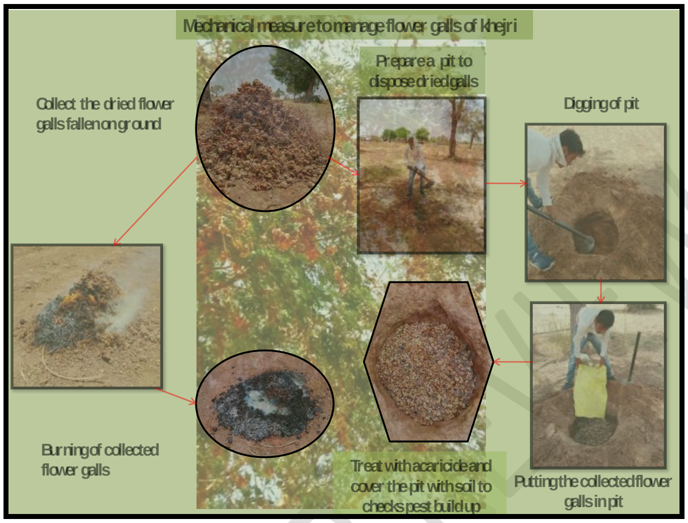

Fig 2: Removal of fallen dried flower galls of khejri

According to [12] as buds break in the spring, overwintering females of mites emerge from protective locations to lay eggs and graze on new foliage. The best opportunity for applying insecticides is now to keep the mite population from causing economic harm. Therefore, dried flower galls that have fallen to the ground must be mechanically removed in order to stop overwintering females from laying eggs on the new foliage at the time of bud initiation.

B) Lopping of trees for the management of Khejri flower galls

Khejri is traditionally pruned in December and November in Rajasthan. The flowering behavior in khejri is influenced by the pruning techniques. In the un-lopped khejri trees first growth flush occurs in the spring, from February to March, and it coincides with flowering. When the pods reach full maturity in June, the second growth begins, and it continues as the monsoon and rainy season begin. Using this as a base, studies with three treatments and three replications were set up using a Randomized Block Design at five different sites. Three different looping treatments were used: one at a one-year interval (T1), two at a two-year interval (T2), and three at a three-year period (T3).

Comment [MP12]: Write November first

Comment [MP13]: It is just like materials and methodology, that is not suitable in result section

The first lopping was done in Oct. 2018 (Fig 3). The level of incidence of flower gall was assessed after lopping in different treatments along with control at all five selected sites (Table 1 & 2; Fig 4 to 7). The data in March-April 2019 revealed that there was no flowering and fruiting in the lopped khejri's and the average galls per inflorescence and average number of pods per inflorescence in control was 15.99 and 5.3 respectively. Our results are in agreement with those of [34], who claimed due to the new shoots immaturity during the khejri flowering season, pruned trees do not produce flowers during February to March, and as a result, no pods are produced. At each of the sites that were chosen, the galls per inflorescence on average and the pods per inflorescence on average were recorded. According to the data gathered, T1 (looping at a one-year interval) performed the best when compared to the control, followed by T2 (looping at a two-year interval).

Fig 3: Lopped khejri tree

In treatment T1, the average number of pods per inflorescence was 5.16 in 2018, rising to 10.7 in 2020 and 10.79 in 2022, while the average number of galls per inflorescence was 15.22 in 2018, falling to 5.15 in 2020 and 4.93 in 2022. In treatment T2, the average number of pods per inflorescence was 5.17 in 2018, rising to 10.41 in 2020 and reducing to 7.87 in 2021, while the average number of galls per inflorescence was 15.52 in 2018, falling to 5.19 in 2020 and 7.08 in 2021. Whereas in control the average number of pods per inflorescence was 5.30 in 2018, 5.39 in 2019, 5.19 in 2020, 5.175 in 2021 and 5.44 in 2022, while the average number of galls per inflorescence was 15.99 in 2018, 15.01 in 2019, 14.95 in 2020, 16.29 in 2021 and 14.60 in 2022. The results reflect that in treatment where lopping was done at two years interval the galls after one year of lopping were less but increased after increased in second year. The gall formation was highest in control and least in T1 where lopping was done at an interval of 1 year (Fig 4, 5, 6 & 7) also pod per inflorescence was maximum in T1 and least in control. Thus lopping at an interval of one year is recommended as it reduces the average number of gall formation.

Comment [MP14]: But total pod formation from three years at 3 years loop is highest than T1 or T2. Accordingly, result should be presented with proper justification which one is best and why for ultimate recommendation. Based on5 years trial some sort of prediction beyong 5 years may be considered for sustainable yield

[34] Reported that regular tree pruning and annual pruning led to the lowest possible long yield and no sangri production. Trees lopped in alternate years and in rotations for long produced the maximum yield. In another study [18] [19] concluded that gall formation was 49.5% of the

inflorescence in unlopped trees, which resulted in a pod production as low as 3.37%. In contrast, gall formation was greatly decreased (5.56%) in trees that had been lopped, and as a result, pod production was 13.3% greater. These findings also support the present findings which reveal that practice of lopping after one year check the populations build up of khejri flower gall mite and reduces the flower gall formation. The results were found to be in line with [13] who reported that better control of *Aceria pallida* Keifer causing galls in goji berry *Lycium barbarum* L. was accomplished with artificial defoliation than pesticides. According to published accounts of *P. glandulosa*, pruning has been shown to promote increased tree growth [31]. According to the results of the current study, lopping at intervals of one year is beneficial for increasing the pods per inflorescence and decreasing the flower galls per inflorescence.

			
Fig 4: Pod & galls in Control	**Fig 5:** Pod & galls in lopping at 3 year interval	**Fig 6:** Pod &galls in lopping at 2 year interval	**Fig 7:**Pod&galls in lopping at 1 year interval

Comment [MP15]: Follow strictly the guideline of the journal for discussion. Is it separately or combined with result part to be discussed?

Table: 1 Effect of lopping at different time interval average number of galls at different sites

Comment [MP16]: Correct the table title

Treatment/ Interval	Sites	Average No galls per inflorescence under different lopping treatments (Yearly)				
		2018	2019	2020	2021	2022
T1(1 year)	Phalodi	14.90	No flowering and fruiting in Feb-March as new flush starts after first lopping	5.24	No flowering and fruiting in Feb-March as new flush starts after second lopping	5.03
	Lohawat	15.70		5.15		4.99
	Osian	14.60		5.14		4.97
	Pipar	15.40		5.12		4.85
	Baori	15.50		5.08		4.80
	Average	15.22		5.15		4.93
T2(2 year)	Phalodi	15.30		5.26	7.27	No flowering and fruiting in Feb-March as new flush starts after second lopping
	Lohawat	16.10		5.21	7.19	
	Osian	15.40		5.25	7.08	
	Pipar	15.40		5.12	6.95	
	Baori	15.40		5.08	6.92	
	Average	15.52		5.19	7.08	
T3(3 year)	Phalodi	15.00		5.22	7.37	13.33
	Lohawat	15.60		5.17	7.22	13.23
	Osian	15.80		5.18	7.1	13.19
	Pipar	14.50		5.18	6.91	13.01
	Baori	15.40		5.13	6.84	12.89
	Average	15.26	-	5.18	7.09	13.13
Control		15.99	15.01	14.95	16.29	14.60

Table: 2 Effect of lopping at different time interval average number of pods per inflorescence at different sites

Treatment/ Interval	Sites	Pods per inflorescence under different lopping treatments (Yearly)				
		2018	2019	2020	2021	2022
T1(1 year)	Phalodi	5.40	No flowering and fruiting in Feb-March as new flush starts after first lopping	10.82	No flowering and fruiting in Feb-March as new flush starts after second lopping	11.29
	Lohawat	5.17		10.72		10.75
	Osian	5.13		10.65		10.66
	Pipar	5.07		10.63		10.62
	Baori	5.03		10.68		10.62
	Average	5.16		10.70		10.79
T2(2 year)	Phalodi	5.27		10.45	7.93	No flowering and fruiting in Feb-March as new flush starts after second lopping
	Lohawat	5.27		10.40	7.88	
	Osian	5.13		10.38	7.84	
	Pipar	5.1		10.38	7.82	
	Baori	5.1		10.43	7.88	
	Average	5.17		10.41	7.87	
T3(3 year)	Phalodi	5.23		10.80	7.92	5.64
	Lohawat	5.17		10.48	7.86	5.65
	Osian	5.1		10.43	7.8	5.61
	Pipar	5.07		10.39	7.82	5.59
	Baori	5.13		10.41	7.88	5.63
	Average	5.14		10.50	7.86	5.62
Control		5.30	5.39	5.19	5.17	5.44

C) **Chemical, botanicals and entomopathogens**: Effects of botanicals, entomopathogens and chemicals were evaluated at five selected locations viz., Phalodi, Lohawat, Pipar, Osia, Baori against flower galls of khejri from 2018 to 2022 : entomopathogens viz., *Beauveria bassiana, Metarhizium anisopliae, Hirsutella Thompsonii, Lecanicillium* lecanii and *Paecilomyces fumosoroseus* and botanicals viz., *Putranjiva roxburgii, Balanites aegyptiaca, Calotropis procera, Murraya koenigii, Eucalyptus, Annona squamosa*, Javik kheti, Germentech(Azadirachtin), different insecticides Abamection, Imidacloprid, Diafenthiuron 25% WW + Pyriproxyfen 5% WW, Spiromesifen, chlorfenapy and control. First spray was done at the bud initiation and the second after 15 days on marked trees. The average number of galls per inflorescence and average number of pods per inflorescence post treatment was recorded.

Based on data collected it was found that 5.84 average no. of galls per inflorescence were observed in treatment with *Putranjiva roxburgii* (10%), 5.78 average no. of galls per inflorescence in *Balanites aegyptiaca* (10%), 7.15 average no. of galls per inflorescence in *Metarhizium anisopliae* 2.5 x 10^7 conidia /ml; 4.77 average no. of galls per inflorescence in abamectin 1.9% EC @1ml/L and 5.2 average no. of galls per inflorescence in treatment with diafenthiuron 25% WW + Pyriproxyfen 5% WW @ 2ml/L (Table 3; Fig 8). Average no. of pods per inflorecence in treament with *Putranjiva roxburgii* (10%) was at par with average no. of pods per inflorecence in treatment with *Balanites aegyptiaca* (10%) i.e 10.10 & 10.14 respectively; 8.26 average no. of pods per inflorescence in treatment with *Metarhizium anisopliae* 2.5 x 10^7 conidia /ml; 11.08 average no. of pods per inflorescence in treatment with abamectin 1.9% EC @1ml/L and 10.24 average no. of pods per inflorescence in treatment with diafenthiuron 25% WW + pyriproxyfen 5% WW @ 2ml/L (Table 4; Fig 9).

Comment [MP17]: MM? not result?

Comment [MP18]: This is not a complete sentense.

Comment [MP19]: Should be given in MM part, not in result

Comment [MP20]: Need not to keep both table and figure for same data. Keep only one of them. Apply it for all such other cases, if any

Comment [MP21]: Sentense construction provided with data is poorly presented. It needs improvement in sweet sequence

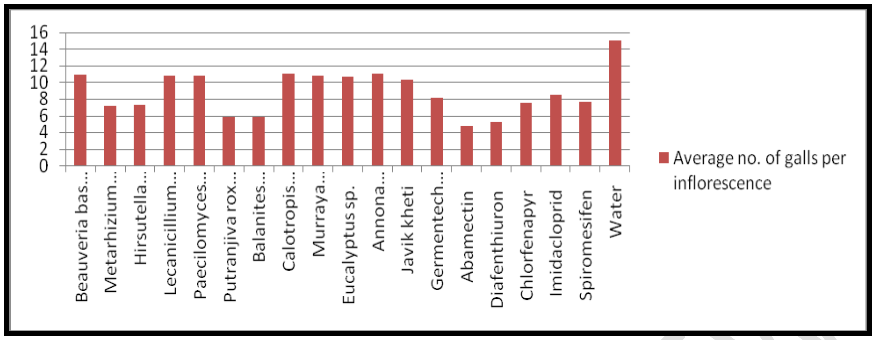

Fig 8: Average No. of galls formed per inflorescence in different treatments

Table 3: A Efficacy of different treatments under management trial against Khejri flower gall (Average No. of galls per inflorescence)

Comment [MP22]: delete

Comment [MP23]: delete

Treatment/ Interval		Doses	2018-19	2019-20	2020-21	2021-22	Average
			Average No. of galls	Average No. of galls	Average No. of galls	Average No. of galls	
T1 Entomopathogens	*Beauveria bassiana* 2.5 x 10^7 conidia /ml	2g/lit	10.92	10.92	11.15	10.83	10.95 ±0.06
	Metarhizium anisopliae 2.5 x 10^7 conidia /ml	2g/lit	7.18	7.11	7.25	7.07	7.15 ±0.03
	Hirsutella Thompsonii 2 x10^8 conidia /ml	2g/lit	7.28	7.26	7.31	7.18	7.26 ±0.02
	Lecanicillium lecanii 1x10^7 conidia /ml	2g/lit	10.82	10.79	10.92	10.77	10.83 ±0.03
	Paecilomyces fumosoroseus 1.5x 10^8 conidia /ml	2g/lit	11.25	10.47	11.27	10.28	10.82 ±0.25
T2 Botanicals /biopesticides	*Putranjiva roxburgii*	10%	5.97	5.82	5.834	5.754	5.84 ± 0.04
	Balanites aegyptiaca	10%	5.94	5.75	5.72	5.71	5.78 ± 0.05
	Calotropis	10%	10.99	10.88	11.24	10.78	10.97

	procera						±0.09
	Murraya koenigii	10%	11.19	10.71	11.22	10.25	10.84 ±0.22
	Eucalyptus sp.	10%	11.16	10.61	11.21	9.89	10.72 ± 0.3
	Annona squamosa	10%	11.23	11.00	11.26	10.39	10.97 ± 0.2
	Javik kheti	1.5ml/ lit.	10.35	10.21	10.41	10.10	10.27 ± 0.06
	Germentech (Azadirachtin) @ 0.15% EC	20ml/ lit.	8.09	7.89	8.76	7.75	8.12 ±0.22
T3 Pesticides	Abamectin 1.9% EC	1ml/ lit.	4.984	4.74	4.99	4.38	4.77 ±0.14
	Diafenthiuron 25% WW + Pyriproxyfen 5% WW	2ml/ lit.	5.34	4.98	5.63	4.85	5.2 ±0.17
	Chlorfenapyr 10% SC	1.5ml/ lit.	7.65	7.48	7.76	7.37	7.57 ±0.08
	Imidacloprid 17.8% S	1ml/ lit.	8.49	8.46	8.62	8.31	8.47 ±0.06
	Spiromesifen 22.9 % SC	1ml/ lit.	7.71	7.64	7.79	7.54	7.67 ±0.05
Control	Water		15.52	14.31	15.89	14.26	14.99 ±0.41

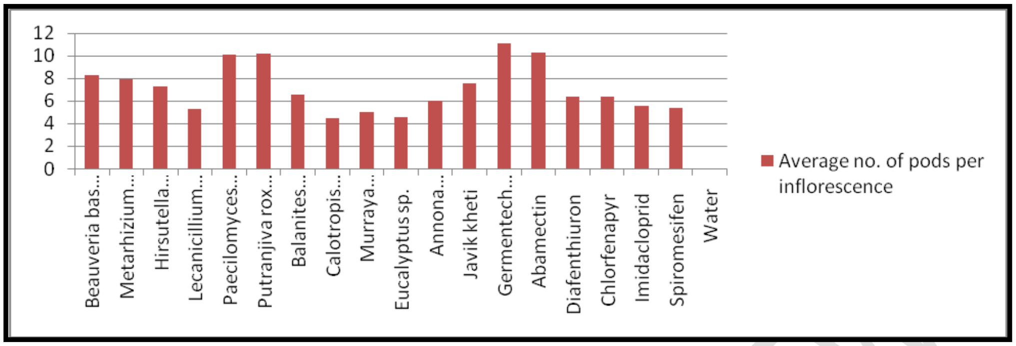

Fig 9: Average No. of pods formed per inflorescence in different treatments

Table 4: Efficacy of different treatments under management trial against Khejri flower gall (Average no. of pods)

Treatment/ Interval		Doses	2018-19	2019-20	2020-21	2021-22	Average
			Average No. of pods	Average No. of pods	Average No. of pods	Average No. of pods	
T1 Entomopathogens	*Beauveria bassiana* 2.5 x 10^7 conidia /ml	2g/lit.	5.86	6.02	5.88	6.1	5.97±0.05
	Metarhizium anisopliae 2.5 x 10^7 conidia /ml	2g/lit.	8.22	8.22	8.22	8.38	8.26±0.04
	Hirsutella Thompsonii 2 x10^8 conidia /ml	2g/lit.	7.86	7.82	7.82	8.08	7.89±0.06
	Lecanicillium lecanii 1x10^7 conidia /ml	2g/lit.	7.3	7.28	7.24	7.34	7.29±0.02
	Paecilomyces fumosoroseus 1.5x 10^8 conidia /ml	2g/lit.	5.24	5.26	5.26	5.4	5.29±0.03
T2 Botanicals /biopesticides	*Putranjiva roxburgii*	10%	10.02	10.16	9.94	10.26	10.10±0.07

	Balanites aegyptiaca	10%	10.06	10.14	10.02	10.32	10.14±0.06
	Calotropis procera	10%	6.42	6.64	6.42	6.64	6.53±0.06
	Murraya koenigii	10%	4.4	4.44	4.36	4.56	4.44±0.04
	Eucalyptus sp.	10%	4.88	5.12	4.86	5.16	5.01±0.07
	Annona squamosa	10%	4.54	4.6	4.52	4.6	4.57±0.02
	Javik kheti	1.5ml / lit.	5.88	6.04	5.86	6.16	5.99±0.07
	Germentech (Azadirachtin) @ 0.15% EC	20ml/ lit.	7.46	7.66	7.48	7.64	7.56±0.05
T3 Pesticides	Abamectin 1.9% EC	1ml/ lit.	11.08	11.22	10.58	11.44	11.08±0.08
	Diafenthiuron 25% WW + Pyriproxyfen 5% WW	2ml/ lit.	10.12	10.26	10.14	10.42	10.24±0.06
	Chlorfenapyr 10% SC	1.5ml / lit.	6.34	6.44	6.28	6.44	6.38±0.03
	Imidacloprid 17.8% S	1ml/ lit.	6.32	6.38	6.28	6.46	6.36±0.03
	Spiromesifen 22.9 % SC	1ml/ lit.	5.46	5.64	5.34	5.6	5.51±0.06
Control	Water		5.36	5.44	5.18	5.58	5.39±0.18

4. Discussion

As the *Eriophyes prosopidis* induced flower galls Several plant extracts have been reported to exhibit antimicrobial and pesticidal properties [7][25]. Plant metabolites and plant-based insecticides are known to have a low environmental impact and offer no harm to consumers when compared to synthetic pesticides [39]. In the present work, we demonstrated

Comment [MP24]: Correct the sentence

Comment [MP25]: This is general statement, no need to present here in discussion part that *Balanites aegyptiaca*, *Putranjiva roxburgii*, *Metarhizium anisopliae*, *Abamectin* and Diafenthiuron 25% WW + Pyriproxyfen 5% WW were found effective in the management of flower galls of khejri.

Our finding were in line with the other researchers who recported that different plant parts from *Balanites aegyptiaca* (L.) Del can be utilized as botanical insecticide since they have promising findings for their botanical and insecticidal actions against a variety of pests. *Balanites aegyptiaca* fruit kerenel was found to be effective against mosquito larva of *Aedes aegypti*, *Aedes arabiensis* and *Culex quinquefasciatus*[20].Additionally,[8][26] reported in ecticidal and repellency activity of *Balanites aegyptiaca* acetone leaf extract against cowpea bruchid *Callosobruchus maculates*, *Castaneum tribolium* and *Trogoderma granarium*. When tested against the insect *Bruchus pisorum*, *Putranjiva* seed oil has shown great repellence in a little dosage of 0.02 ml, in contrast to other oils that failed to demonstrate the same repellence in the same amount. Due to its high toxicity insects, *P. roxburghii* oil protected the peanut seeds for six months[21].

Furthermore, numerous reports are available on the field effectiveness of the mitosporic entomopathogenic fungus *Metarhizium anisopliae* against Acari. In actuality, entomopathogenic fungi (EPF) are being evaluated as a rational alternative to mite management through biological means [22][10]. According to [24] *M. anisopliae* has a high level of effectiveness against the eriophyoid mite, *Phyllocoptes gracilis*, which significantly reduces the yield of organic raspberries in Europe. [9] has reported high efficacy of M. anisopliae against Tetranychus urticae a pest of common bean plants in field conditions.

Abamectin alone or in combination with a mineral oil, sulfur, hexythiazox, and fenpyroximate is highly effective against *A. litchii* according to [4]. The most effective tested miticide, according to [11], was abamectin. According to [36] diafenthiuron 25% + pyriproxyfen 5% SE were found to be more efficient against sucking insect pests such as aphids, leafhoppers, whiteflies, and thrips in Bt cotton.

Comment [MP26]: All scientific name should be in italics

Comment [MP27]: Discussion should be in line of present mite problem with mentioned host. If earlier evidences in suppor of your direct work is scanty, then you take credit by highlighting your initiation as for the first time report or work. No discussion is done about the result of other treatments including mechanical and general aspects what is mentioned here.

5. Conclusions

Eriophyes prosopidis induced flower galls are responsible for loss of pods and seeds production in *P. cineraria*. The gall-infested trees look unwell because they have a lot of disorganized and deformed green galls hanging from them. During the field trials of present study we found that the infestation of this mite can be managed by integrated management approach. The mechanical removal of dried galls fallen on surface and lopping at an interval of one year can reduce the infestation considerably. Treatment with botanicals *Putranjiva roxburgii* (10%) leaf extract, *Balanites aegyptiaca* (10%) leaf extract, fungal spray of Metarhizium anisopliae 2.5 x 10^7 conidia /ml and chemicals Abamectin 1.9% EC @1ml/L and Diafenthiuron 25% WW + Pyriproxyfen 5% WW @ 2ml/L can be utilized for effective management of flower galls of *P. cineraria*.

Data Availability Statement: The data presented in this study are available in article.

Comment [MP28]: Should be in style of the journal, check accordingly for repeated times

References

1. Armstrong W. P.To be or not to be a gall. Pacific Horticulture,1995, 56: 39-45.
2. Abdel BE, Fahmy G Al, Thani N Al, Thani R and Abdel-Dayem M. The Ghaf Tree, *Prosopis cineraria* in Qatar. Qatar University and National Council for Culture, Arts and Heritage, Doha, 2007, 38p.
3. Arya S. Kumar N. and Toky O. P. *Khejri* (*Prosopis cineraria* L. Druce)*:* Its value, Research and Extension, HDRA-ODA Project, India, 1995,131p.
4. Azevedo L. H., Moraes G. J., Yamamoto P.T., Zanardi O.Z. Development of a methodology and evaluation of pesticides against *Aceria litchii* and its predator *Phytoseius intermedius* (Acari: Eriphyidae, Phytoseiidae). Insecticide Resistance and Resistance Management, 2013, 106: 2183–2189.
5. Bhansali, R. Raj. Biology and Multiplication of *Prosopis* species Grown in the Thar Desert, In Desert Plants Biology and Biotechnology (Ed KG Ramawat). Springer Berlin Heidelberg, 2010, pp 371-406.
6. Bhansali, R. Raj. Development of flower galls in *Prosopis cineraria* trees of Rajasthan. The Journal of Plant Protection Sciences, 2012, 4(1): 52-56.
7. Bhatnagar, D., Zeringue, H. J. and Cormick, S. P. Neem leaf extracts inhibit aflatoxin biosynthesis in *Aspergillus flavus* and *A. parasiticus*. In Proceedings of the USDA neem workshop, 1990, pp. 118–127).
8. Bruchidae, C., Nwaogu, J., Yahaya, M. A., & Bandiya, H. M. Insecticidal efficcay of oil extracts of *Balanites aegyptiaca* seeds and cashew nuts against *Callosobruchus maculatus* Fabr. (Coleoptera: Bruchidae). African Journal of Agricultural Research, 2013, 8(25), 3285–3288.
9. Bugeme David Mugisho , Knapp Markus, Ekesi Sunday, Chabi-Olaye Adenirin, Boga Hamadi Iddi and Maniania Nguya Kalemba. Efficacy of *Metarhizium anisopliae* in controlling the two-spotted spider mite *Tetranychus urticae* on common bean in screenhouse and field experiments. Insect Science (2015) 22, 121–128, DOI 10.1111/1744-7917.12111.
10. Chandler, D., Davidson, G. and Jacobson, R.J. Laboratory and glasshouse evaluation of entomopathogenic fungi against the two-spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae), on tomato, *Lycopersicon esculentum*. Biocontrol Science and Technology, 2005, 15, 37–54.
11. Chong, J. H. and M. Brown. Bermuda grass mite: searching for management solutions. Golf Course Magazine, 2018,12: 58–63.
12. Davis Ryan S. Eriophyid Mites Bud, blister, gall, and rust mites. Utah PestsExtension, 2011. Retrived https://extension.usu.edu/pests/research/eriophyid-mites on 19.7.23.

13. Li J, Liu S, Guo K, Qiao H, Xu R, Xu C, Chen J. A new method of gall mite management: application of artificial defoliation to control *Aceria pallida*. PeerJ , 2019, 7:e6503 http://doi.org/10.7717/peerj.6503.
14. Gold, A.G. and B.R. Gujar. In the time of trees and sorrows. Nature, power, and memory in Rajasthan. Duke University Press, Durham & London, UK. 2002, 403 p.
15. Gadgil, M. and R. Guha. This fissured land. An ecological history of India. Oxford University Press, Delhi, India. 1992, 274 p.
16. Gupta, J.P. Auxin and IAA oxidase activity related to the leaves gall formation in some forest trees. Science Research Reporter, 2011, 1:108-11.
17. Gupta, R.K. and I. Prakash . Environmental analysis of the Thar Desert, English Book Depot, Dehra Dun, 1975, pp 70- 236.
18. Kumar, S. and S.I. Ahmed. Seasonal occurrence and population fluctuation of *Eriophyes prosopidis* Sexena, a leaf and inflorescence gall mite of *Prosopis cineraria* (Khejri) in Rajasthan. Indian Journal of Forestry, 2006, 29: 287- 92.
19. Kumar S Ahmed S I. A world-wide check-list of insect pest spectrum of *Prosopis* spp., with new pest records of *P. cineraria* and *P. juliflora* from Indian arid and semi-arid areas. My Forest, 2004, 40: 85-11.
20. Mageed, A. A. *Balanites aegyptiaca* as a Mosquito Larvicide Larval mortalities The percentage mortalities of the second and fourth instar larvae of mosquito. 1990, 28(4), 267–271.
21. MahendraDas Dharmendira Kumar, Supriya B., Vijayakumar Keerthana, Subramanian Nambirajan. Medicinal values of *Putranjiva roxburghii*-a review. International Journal of Current Pharmaceutical Research, 2017, 9 (5):5-8.
22. Maniania, N.K., Bugeme, D.M., Wekesa, V.W., Delalibera, I. Jr. and Knapp, M. Role of *entomopathogenic* fungi in the control of *Tetranychus evansi* and *Tetranychus urticae* (Acari: Tetranychidae) pests of horticultural crops. Experimental and Applied Acarology, 2008, 46, 256–274.
23. Mc Kay F and Gandolfo D. Phytophagous insects associated with the reproductive structures of mesquite (*Prosopis* spp.) in Argentina and their potential as biocontrol agents in South Africa. African Entomology, 2007, 15: 121-31.
24. Minguely Camille, Norgrove Lindsey, Burren Alexander and Christ Bastien . Biological Control of the Raspberry Eriophyoid Mite *Phyllocoptes gracilis* using Entomopathogenic Fungi. Horticulturae, 2021, 7(3):54; https://doi.org/10.3390/ horticulturae7030054.
25. Mohana .D.C. and Raveesha , K.A. Anti- Bacterial activity of *Casealpinia coriaria* against plant pathogenic *Xanthomonas pathovars* .Journal of Agricultral technology, 2006, 2:317-327.
26. Mohamed, N. M. A. Efficacy of Selected Plants Extracts on the Control of Khapra Beetle *Trogoderma granarium* Everts. (Coleoptera – Dermistidae) and Red Flour Beetle *Tribolium castaneum* Herbst. (Coleoptera – Tenebrionidae). Ph.D Thesis, 2003, University of Khartoum, Sudan,.
27. Rathore, M. Nutrient content of important fruit trees from arid zone of Rajasthan. Journal of Horticulture and Forestry, 2009, 1: 103-08.
28. Parihar, D.R. Insect fauna of Khejri, *Prosopis cineraria* of arid zone. Indian Journal of Forestry, 1993, 16: 132-37.
29. Parihar DR. Galls and gall-makers in *Khejri* (*Prosopis cineraria* Linn. Druce) of arid zone of India. Annals of the Arid Zone, 1994, 33: 313-17.
30. Pareek, A. K.; Garg, S.; Kumar, M.; Yadav, S. Y. *Prosopis cineraria*: a gift of nature for pharmacy. Int. J. Pharma Sci. Res., 2015, 6 (6): 958-964.

31. Patch Nancy L. and Felker Peter. Influence of silvicultural treatments on growth of mature mesquite (*Prosopis glandulosa* var. *glandulosa*) nine years after initiation. Forest Ecology and Management, 1997, 94(1–3):37-46.
32. Ramani, V. and U. Kant. Phenolics and enzyme involved in phenol metabolism of gall and normal tissues of *Prosopis cineraria* (Linn.) in vitro and in vivo. Proceedings Indian National Science Academy, 1989, (5&6): 417-20.
33. Russo RA. Field Guide to Plant Galls of California and Other Western States. Univer-sity of California Press, Berkeley, California, 2006, 397p.
34. Samadia D.K., Haldhar S.M., Verma A.K., Gurjar P.S., Berwal M.K., Gora J.S., Kumar Ramesh & Ram Hanuman. Khejri (*Prosopis cineraria*) research for horticultural harnessing and environmental services: an appraisal. Journal of Agriculture and Ecology,2021, *12: 1-26.*
35. Satya Vir and S.K. Verma . Insect Pests of Agroforestry Leguminous Trees in India. Annals of Arid Zone, 1996, 35(4): 349-359.
36. Shorthouse J. D. and Rohfritsch O. Biology of In-sect-Induced Galls. Oxford University Press, 1992.
37. Tewari, J.C., Harsh, L.N. Forestry research in arid tract of India. In: Faroda AS, Manjit S (eds) Fifty Years of Arid Zone Research in India, Central Arid Zone Research Institute, Jodhpur, 1998, pp 307–322.
38. Thumar R.K., Borad P.K., Pathan N.P., Bharpoda T.M., Saiyad M.M. and Chaudhary H.K. Bio-efficacy of diafenthiuron 25% + pyriproxyfen 5% SE against sucking insect pests of Bt Cotton. Journal of Entomology and Zoology Studies 2018; 6(5): 1024-1029.
39. Verma. J. and Dubey, N. K. Prospectives of Botanicals and Microbial products as Pesticides of tomorrow. Current Science, 1999, 76: 172-179.
40. Vir S. Bruchid infestation of leguminous trees in the Thar Desert. Tropical Science, 1996, 36:11-13.