Effect of weevil infestation on maize seed and feed quality at different storage periods

ABSTRACT

In the seed /grain samples collected from six months old stock, the highest mean number (32.33) of rice weevils were recorded in Venkatesh Poultry Feed, Karimnagar and Sanjeev Reddy poultry feed, Nizamabad with per cent damage 14.50 and 13.63 per cent respectively. The significantly highest population of rice weevils were recorded in the one year old samples collected from Sharanya Poultry Feed, Karimnagar (36.00) with per cent damage 13.07 %. Similarly the highest mean population of rice weevils were recorded in MARKFED, Ranga reddy (187.67) with per cent damage 53.33 in samples collected from two years old seed stocks. The data indicate population buildup from six months to one year was not significant but population increased by five to six folds from six months to two years storage duration. Germination percentage of the maize samples collected from different locations from six months, one year and two years old stocks showed negative and highly significant relationship with population of *Sitophilus oryzae* (L.) (-0.86, 0.92 and 0.99, respectively) and similar trend was observed with its infestation (-0.87, -0.96 and -0.99, respectively). While, moisture content (per cent) of the maize samples of six months, one year and two years old stocks collected from different location showed positive and non significant relationship with population of *Sitophilus oryzae* (l.) (0.49, 0.51 and 0.78) and with its infestation similar trend was noticed (0.39, 0.46 and 0.80), respectively. The population size of weevils and the storage period are the factors that have the highest influence on seed germination.

Key words: Population level of Rice weevil, weevil Infestation, maize, Seed quality parameters.

1.INTRODUCTION

In India, maize is the third most important food crop after rice and wheat, contributing nearly nine per cent in the national food basket. Maize crop is mostly grown in all the districts of Telangana state. The districts of Mahaboobnagar, Medak, Warangal, Karimnagar and Nizamabad are predominantly growing maize crop. The area, production and productivity of maize crop in Telangana state are 4.12 lakh hectares, 22.26 Lakh tonnes and 5403 kg per hectare, respectively for 2021-22 (Indiastat.com, 2021-22). Usually, maize seeds are often traditionally stored in jute bags in Telangana state. This leads to significant increase of moisture during rainy seasons, thereby creating conducive conditions for grain weevil infestation (Hossain *et al*., 2007; Zunjare *et al.*, 2014). Infested grain fetches lower market value due to reduced weight and nutritional value (Tefera, 2012). Seed viability of the damaged grain is drastically reduced and affects subsequent planting.

A survey was conducted in Nizamabad, Karimnagar and Rangareddy districts of Telangana state to collect the maize seed samples of different storage periods to assess the

impact of infestation on seed quality. The extent of damage by weevil in different seed samples were correlated with the seed quality parameters so that it will be useful in providing a base for developing a new approach which is appropriate and effective for control storage pests in Telangana

2.MATERIAL AND METHODS

2.1 Collection of maize seed samples: A survey was conducted in 23 storage godowns. The maize seed samples of different storage durations (6 months, 1 year and 2 years old seed samples) were collected from different districts of Telangana.

2.2 Assessment of insect pests of maize grain under storage condition

The survey was conducted from June to October, samples of 6, 12 and 18 months storage duration were collected in which seed damage level was most likely to be prevalent. Seed samples were drawn from top, middle and bottom of the container with a sampler, from the storage structures. A total of ninety two seed samples were collected. Three samples were drawn from each container, each of the samples containing 500 g of maize seed. Samples were bulked and 500 g seed prepared as sample. Each sample was put in paper bag and labelled with the necessary information (name of the site, date of sampling, sample number, storage time). The samples procured from the same storage were mixed together and placed in a cloth bag for further inspection. Besides, information on management practices of the storage insect pests, storage structures, storage conditions were also collected and later taken to laboratory for further assessment

2.3 Data collected

2.3.1Adult emergence (Number)

The number of live or dead adult insects emerged per 500 g seeds were counted

2.3.2 Seed damage (per cent)

The seed damage was calculated by taking a random sample of 400 seeds and counting the number of seeds with bored holes by storage insects and converted to percentage.

$$\text{Percentage seed damage} = \frac{\text{Number of damaged seeds}}{\text{Total number of seeds}} \times 100$$

2.3.3 Seed germination percentage

A total of 400 seeds were randomly selected from each treatment and grouped into three replications of 100 seeds each. The germination test was conducted in the laboratory using

between paper methods as per ISTA (1985). One hundred seeds of three replications were placed equidistantly on moist germination paper. The rolled towels were incubated in germination chamber maintained at 25^0C and 90 per cent relative humidity (RH). The first count and final count of germinated seedlings were taken on 7^{th} and 14^{th} day, respectively and the percentage of germination was expressed based on the normal seedlings.

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds taken}} \times 100$$

2.3.4 Mean root length and shoot length (cm)

Ten normal seedlings were selected at random from each treatment. The root length was measured from point of attachment of seed to tip of the longest root and shoot length was measured from the point of attachment of seed to the growing meristematic tip and expressed in centimeters (cm).

2.3.5 Seedling vigour index (SVI-I)

The seedling vigour index was calculated as per the formula given by by Abdul Baki and Anderson (1973).

SVI-I = Germination (%) × mean seedling length (cm).

2.3.6 Seed moisture content at different periods

Moisture content of the seed was estimated by using Dickyjohn moisture meter.

The data on above parameters was statistically analyzed as suggested by Panse and Sukhatme (1978). Simple correlation coefficients were worked out between the effect of *Sitophilus oryzae* incidence on quality parameters.

3.RESULTS AND DISCUSSION

3.1 Effect of *Sitophilus oryzae* (L.) incidence and infestation on quality prameters of six months old seed samples

The mean number *Sitophilus oryzae* recorded in 500 grams maize samples of six months old stock and its effect on quality parameters are presented in Table 1.

There was significant differences between treatment locations the highest mean number (32.33) of rice weevils were recorded in Venkatesh poultry feed, Karimnagar and Sanjeev Reddy poultry feed, Nizamabad with per cent seed/grain damage 14.50 and 13.63 per cent, respectively.

The lowest mean number of rice weevils were recorded in Shiram Bio Seed, Jeedimetla (4.33), and was on par with Ganga Kaver Ltd., Godavally (4.67) caused 1.28 and 1.33 per cent damage, respectively. The mean population of *S. oryzae* in the rest of the locations vary from 6.33 to 25.00 and its damage ranged from 1.44 to13.41per cent.

There was significant differences between treatment locations with respect to seed quality attributes viz., germination percentage, Seedling Vigour Index and moisture content.

Highest germination percentage and seedling vigor index was recorded in Shiram Bio Seed, Jeedimetla (99.67 per cent and 3214), while lowest germination and Seedling vigour index was observed from the samples of Sanjeev Reddy Poultry Feed (73.67 per cent and 1876) followed by Sri Rama Poultry Feed, Ranga reddy (74.33 and 1876) while in the rest of the locations germination percentage vary from 84.67 – 96.00 per cent and Seedling Vigour Index vary from 2200 to 2755. The moisture content in six months old samples at different locations vary from 10.87-12.27. The highest moisture per cent was observed in the samples from the Sanjeev Reddy poultry feed (12.27 per cent) where as lowest moisture per cent was observed in Sri Rama Poultry Feed Ranga reddy (10.40 per cent).

3.2 Effect of *Sitophilus oryzae* (L.) incidence and infestation on quality parameters of one year old seed samples

The mean number *Sitophilus oryzae* recorded in 500 grams maize samples of one year old stock and its effect on quality parameters are presented in Table 2.

There was significant differences between treatment locations The significantly highest population of rice weevils were recorded in Sharanya Poultry Feed, Karimnagar (36.00) followed by MARKFED, Nizamabad (29.00) with per cent damage 13.07 and 7.17 per cent, respectively.

The lowest mean number of rice weevils were recorded in Nuziveed Seeds, Kompally (12.00), and caused 2.55 per cent damage. The mean population of *S. oryzae* in the rest of the locations vary from 14.67- 23.33 and its damage ranged from 3.29 – 5.08 per cent.

There was significant differences between treatment locations with respect to seed quality attributes viz., germination percentage, Seedling Vigour Index and moisture content.

Highest germination percentage and seedling vigor index was recorded in Nuziveed Seeds, Kompally (83.00 per cent and 1846) and on par with Ganga Kaver Ltd., Godavally (82.00 and 1919.00). The lowest germination and Seedling vigour index was observed from the samples of Sharanya Poultry Feed, Karimnagar (21.67 and 1050) and while in the rest of the locations germination percentage vary from 46.00 – 69.00 % and seedling vigour index ranged from 1290 to 1662. The moisture content in the one year old samples at different locations vary from 11.45 - 12.96 per cent. The highest moisture per cent was observed in the samples from the Sharanya Poultry Feed, Karimnagar (12.96 per cent) where as lowest moisture per cent was observed in Nuziveed Seeds, Kompally (12.13 per cent).

3.3 Effect of *Sitophilus oryzae* (L.) incidence and infestation on quality prameters of two year old seed samples

The mean number *Sitophilus oryzae* recovered in 500 grams samples of two year old stock and its effect on quality parameters are presented in Table 3.

There was significant differences between treatment locations The significantly highest population of rice weevils were recorded in MARKFED, Ranga reddy (181.67) followed by MARKFED, Nizamabad (165.33) with per cent damage 53.33 and 48.17 per cent respectively.

The lowest mean number of rice weevils were recorded in Ganga Kaver Ltd., Godavally (5.33) and caused 3.46 per cent damage.

There was significant differences between treatment locations with respect to seed quality attributes viz., germination percentage, Seedling Vigour Index and moisture content.

Highest germination percentage and seedling vigor index was recorded in Ganga Kaver Ltd., Godavally (71.67 per cent and 1511) followed by seed samples collected from Nuziveed Seeds, Kompally (65.00 and 1447.00). The lowest germination and Seedling vigour index was observed from the samples of MARKFED, Ranga reddy (5.00 and 72). The germination percentage recorded in samples of MARKFED, Nizamabad (14.33 per cent) and MARKFED, Karimnagar (43.67 per cent) with Seedling Vigour Index 875 and 995, respectively. The moisture content in the two years old samples at different locations vary from 14.00-15.57 per cent. The highest moisture per cent was observed in the samples from the MARKFED, Ranga reddy (15.57 per cent) where as lowest moisture per cent was observed in Ganga Kaver Ltd., Godavally (14.00 per cent).

In the seed /grain samples collected from six months old stock, the highest mean number (32.33) of rice weevils were recorded in Venkatesh Poultry Feed, Karimnagar and Sanjeev Reddy poultry feed, Nizamabad with per cent damage 14.50 and 13.63 per cent respectively. The significantly highest population of rice weevils were recorded in the one year old samples collected from Sharanya Poultry Feed, Karimnagar (36.00) followed by MARKFED, Nizamabad (29.00) with per cent damage 13.07 and 7.17 per cent, respectively. Similarly the highest mean population of rice weevils were recorded in MARKFED, Ranga reddy (187.67) followed by MARKFED, Nizamabad (165.33) with per cent damage 53.33 and 48.17 per cent respectively in samples collected from two years old seed stocks. The data indicate population buildup from six months to one year was not significant but population increased five to six folds from six months to two years storage duration.

Diverse variation observed in the *Sitophilus oryzae* incidence among the locations and samples indicate their adoptability to different abiotic factors. The age of seed stock as well as the maize cultivars from which the samples were drawn. The variation in the pest dominance was also due to source of primary field infestation at seed production centers and the source of secondary cross infestation at local distributors godown. The other source of cross infestation at godowns in the rejected seed by receiving buyers from other parts of the country. Thus, adding infested seed to grain stores without treatment appears to be major source of infestation at godowns. The above observations clearly depict that the prevalence of insect pests is majorly due to the inadequacy of sanitary awareness, which is necessary to keep godowns clean and tidy. Accumulation of filth and refuse near the godowns forms a perpetual and recurring harbourage for insect development. Proper disposal of the sweeping is compelling necessity to reduce the insect activity in the godowns. Cross infestation has been found to be an invariable occurrence. Hence, regular prophylactic measures will help to protect grain from the ravages of the pests.

The findings also indicate that most predominant insect pest that was observed was *S.oryzae,* it may commence from the field just before harvest and the weevils continues to reproduce and destroy the grains or seed even in store. Rice weevil is a major problem in storage.

It cause losses in storage directly through consumption and indirectly making it unfit for planting.

From data recorded in the samples collected at different locations and of different storage duration, one year and two year old stock revealed that lowest germination and seedling vigour index was observed from the samples of Sanjeev Reddy Poultry Feed (73.67 per cent and 1334) and Venkatesh Poultry Feed, Karimnagar (74.33 and 1876) from six months old stock, Sharanya Poultry Feed, Karimnagar (21.67 and 1050) from one year old stock and MARKFED, Ranga reddy (5.00 and 15.57) from two years old stock Results indicate that the loss of maize seed/grain increases with the increase in storage period and with the increase in weevil population resulted in reduction in germination and Seedling Vigour Index.. The rice weevil, *S. oryzae* being an internal feeder where internal infestation might have resulted in a progressive reduction of germination which was influenced by the infestation level and the storage period. Similar to the present studies, Hall (1971) has reported that, insect internal infestation has affected the physiological quality of seeds because most insect species feed preferentially on the tender and high proteonic embryo where one could observe a gradual decrease in germination with increase in the adult emergence.

Yuya *et al*. (2009) reported death of the embryo due to infestation by *S. zeamais* in maize causing consequent loss in germination. Similarly, drastic reduction in viability of maize seeds infested with maize weevil was reported by Santos *et al*. (1990) who recorded decrease in germination from 13% at the egg stage to 93% by adult stage. They also emphasized that, infestation by this pest also led to fungal attack thereby affecting the germination. Sinha and Sinha (1992) reported an increase in the moisture content of grains, *Aspergillus flavus* infection and aflatoxin accumulation in contrast to a decrease in germinability as a result of infestation by *S. oryzae* in maize. Similarly, Giga *et al*. (1991) reported that damaged seeds had low per cent germination and reduced weight and market values as evidenced in the present results.

The moisture content (per cent) of seeds increases, proportionally to the infestation level and storage duration. In the six months old samples, the moisture content was ranged from 10.87-12.27 per cent, 11.45 to 12.96 per cent in one year old seed/grain samples and 14.00 to 15.57 per cent in two year old samples. These data demonstrated the effect of metabolic activity of insects and molds on the content of water of corn seeds, as verified by Christensen and Kaufman, 1969; Howe, 1973 and Matoli *et al*.,1979

3.4 CORRELATION COEFFICIENTS BETWEEN QUALITY PARAMETERS and *SITOPHILUS ORYZAE* (L.) INCIDENCE AND ITS DAMAGE ON MAIZE

3.4.1 Germination Percentage

Germination percentage of the maize samples collected from different locations from six months, one year and two years old stocks showed negative and significant relationship with population of *Sitophilus oryzae* (L.) (-0.86, 0.92 and 0.99, respectively) and similar trend was observed with its infestation (-0.87,-0.96 and -0.99, respectively).

3.4.2 Seedling Vigor Index

Seedling Vigor Index of the maize samples collected from different location from six months, one year and two years old stocks showed negative and significant relationship with population of *Sitophilus oryzae* (L.) (-0.76,-0.90 and -0.90), respectively and similarly negative and significant relationship was found respect to its infestation due to *S. oryzae* in six months, one year and two year old seed stocks (-0.79, -0.85 and-0.90), respectively

Germination turned up to show high inverse correlation with the number of insects, with internal infestation. Matiole *et al*. (1979) working with the rice weevil *S. oryzae* in corn, verified that the population size and the storage period are the factors that have the highest influence on seed germination. According to Hall (1971), insect internal infestation affects the physiological quality of seeds because most insect species feed preferentially on the tender and high proteic embryo.

The number of damaged kernels showed a high negative correlation with the percentage of germination. Thus, insect infestation significantly reduces the physiological quality of the corn seeds and affects the seed grading commercially.

Internal infestation progressively resulted in a reduction of germination directly proportional to the infestation level and to the storage period

3.4.3 Moister content (per cent)

Moister content (per cent) of the maize samples collected from different location from six months, one year and two years old stocks showed positive and non significant relationship with population of *Sitophilus oryzae* (l.) (0.49, 0.51 and 0.78) and with its infestation similar trend was noticed (0.39, 0.46 and 0.80), respectively.

The elevation of moisture content generally may be a result of the metabolic activity of insects and molds that are usually associated to insects and mites.

4.CONCLUSION

Germination and vigour showed high inverse correlation with the number of insects with internal infestation. The population size of weevils and the storage period are the factors that have the highest influence on seed germination. While, Moisture content (per cent) of the maize samples collected from different location had non significant relationship with population of *Sitophilus oryzae* and with its infestation level.

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Conflict of interests

Authors have declared that no conflict of interests exists.

Table 1. Effect of *S. oryzae* incidence and its damage on quality parameters in six months old samples

S.	Location	No of	Per cent	Germination	Seedling	Moisture

No		*S.oryzae*	damage	percentage	Vigour Index	content
1	Ganga Kaveri Ltd.,Godavally	4.67 (2.26)	1.33 (6.61)	98.33 (82.67)	2653.00	10.97 (19.34)
2	Shriram Bio seed, Jeedimetla	4.33 (2.20)	1.28 (6.50)	99.67 (85.38)	3214.00	10.87 (19.25)
3	Zauari Seeds, Medchal	6.33 (2.60)	2.58 (9.24)	96.00 (78.72)	2600.00	10.93 (19.31)
4	Sonam Seeds, Karimnagar	9.00 (3.08)	2.36 (8.83)	96.00 (78.52)	2534.00	11.07 (19.43)
5	Varun Seeds, Karimnagar	6.33 (2.69)	1.44 (6.86)	97.00 (80.27)	2755.00	11.10 (19.46)
6	Kiranmai Agro Genetics, Nizamabad	9.00 (3.08)	3.44 (10.69)	95.67 (78.00)	2555.00	10.77 (19.16)
7	Sharanya Poultry feed, Karimnagar	25.00 (5.04)	13.41 (21.48)	84.67 (66.96)	2200.00	11.27 (19.61)
8	Venkatesh, Poultry feed, Karimnagar	32.33 (5.73)	14.50 (22.38)	83.67 (66.16)	2224.00	11.23 (19.58)
9	Srinivasa Poultry feed, Nizamabad	9.00 (3.08)	3.98 (11.50)	84.67 (66.95)	2529.00	11.17 (19.52)
10	Sanjeev reddy Poultry feed, Nizamabad	32.33 (5.73)	13.63 (21.65)	73.67 (59.13)	1876.00	12.27 (20.50)
11	Sri Rama Poultry feed, Ranga reddy	23.62 (4.92)	12.38 (20.60)	74.33 (59.56)	1334	10.40 (18.81)
	SEM±	0.13	0.22	0.88	47.23	0.06
	CD (P=0.05)	0.37	0.63	2.58	138.51	0.19
	CV (%)	5.97	2.81	2.09	3.4	0.56

Values in the parenthesis are transformed values

Table 2. Effect of stored grain pest infestation on quality parameters in one year old samples

S. No	Location	*No of S. oryzae*	Per cent damage	Germination percentage	Seedling Vigour Index	Moisture content
1	Ganga Kaveri Ltd.,Godavally	14.67 (3.89)	3.29 (10.45)	82.00 (64.92)	1919.00	12.17 (20.41)
2	Kiranmai Agro Genetics, Nizamabad	22.0 (4.74)	4.29 (11.95)	69.00 (56.17)	1662.00	12.17 (20.41)
3	MARKFED,Rangareddy,District	23.00 (4.85)	4.94 (12.84)	65.00 (53.73)	1352.00	12.13 (20.39)
4	MARKFED, Nizamabad,District	29.00 (5.43)	7.17 (15.51)	54.00 (47.29)	1376.00	12.17 (20.41)
5	MARKFED,Karimnagar,District	23.33	5.08	46.00	1290.00	11.45

		(4.88)	(12.98)	(42.71)		(19.78)
6	Nuziveed Kompally	12.00 (3.53)	2.55 (9.18)	83.00 (65.66)	1846.00	12.13 (20.38)
7	Sharanya poultry feed, Karimnagar	36.00 (6.04)	13.07 (21.19)	21.67 (27.73)	1050.33	12.96 (21.10)
	SEM±	0.144	0.41	0.51	24.09	0.09
	CD (P=0.05)	0.437	1.24	1.53	73.08	0.26
	CV	3.919	5.26	1.71	2.78	0.73

Values in the parenthessis are transformed values

Table 3. Effect of stored grain pest infestation on quality parameters in two year old samples

S. No	Location	No of *S. oryzae*	Per cent damage	Germination percentage	Seedling Vigour Index	Moisture content
1	MARKFED, Rangareddy, District	181.67 (13.50)	53.23 (46.85)	5.00 (12.78)	72.000	15.57 (23.24)
2	MARKFED, Nizamabad, District	165.33 (12.88)	48.17 (43.95)	14.33 (22.21)	875.00	14.50 (22.38)
3	MARKFED, Karimnagar, District	76.33 (8.77)	23.93 (29.28)	43.67 (41.36)	995.00	14.43 (22.33)
4	Nuziveed seeds	36.00 (6.04)	16.16 (23.70)	65.33 (53.93)	1447.00	14.43 (22.33)
5	Ganga Kaveri Ltd., Godavally	5.33 (2.40)	3.46 (17.58)	71.67 (57.84)	1511.00	14.00 (21.97)
	SEM±	0.096	0.39	0.898	22.79	0.11
	CD (P=0.05)	0.30	1.24	2.831	71.8	0.34
	CV (%)	1.91	2.20	4.137	4.03	0.82

Values in the parenthesis are transformed values

Table 4. Correlation coefficients between *Sitophilus oryzae* (L.) incidence and its damage on quality parameters.

	Storage duration		
	Six months old seed samples	**one year old seed samples**	**Two years old seed samples**

***Sitophilus oryzae* (L.) incidence and its damage** / **Quality parameters**	**No of *S. oryzae***	**Per cent Damage**	**No of *S. oryzae***	**Per cent Damage**	**No of *S. oryzae***	**Per cent Damage**
Germination percentage	-0.86**	-0.87**	-0.92**	-0.96**	-0.99**	-0.99**
Seedling Vigour Index	-0.76**	-0.79**	-0.90**	-0.85*	-0.90*	-0.90*
Moisture content (%)	0.49	0.39	0.51	0.46	0.78	0.80

* Significance at 5% Level

** Significance at1 % level

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