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Efficacy of botanicals and animal origin bio products against lesser grain borer *Rhyzopertha dominica* (Fab.) in stored maize

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Abstract
A laboratory experiment was conducted to know the efficacy of plant products and animal origin bioproducts for the management of lesser grain borer *Rhyzopertha dominica* in stored maize seeds during 2017-18. Results revealed significant differences for seed damage, weight loss, moisture reduction, germination percentage and adult mortality. *Acorus calamus* rhizomes @ 2 percent (91.11% and 76.67%) found to be significantly superior among botanicals with highest adult mortality and germination percent up to 180 days after treatment followed by *Annona squamosa* seed powder @ 2 percent (86.67% and 74.33%), and cow dung ash powder @ 2 percent (85.00% and 72.00%) as compared to control check (3.33% and 45.67%) respectively. However minimum seed damage, minimum weight loss and least moisture reduction was recorded by *A. calamus* rhizomes @ 2 percent (6.17%, 0.88% and 11.07%) found to be significantly superior among botanicals up to 180 days after treatment followed by *A. squamosa* seed powder @ 2 percent (10.67%, 0.95% and 11.19%), and cow dung ash powder @ 2 percent (14.67%, 2.30% and 11.26%) as compared to control check (66.58%, 74.39% and 12.05%) respectively.

Keywords: Botanicals, animal origin bio products, *Rhyzopertha dominica,* maize

Introduction
Maize is most widely distributed crop of the world. It is cultivated in tropics, subtropics, temperate and semiarid condition. The world area under maize is 183 m ha with a production of 1065 m t. In India it is being grown on an area of 9.6 m ha with a production of 26 m t with an average productivity of 2710 kg/ha. Karnataka accounts for 1.26 m ha area with a production of 3.31mt and productivity of 2612 kg/ha (Anon., 2016) [2]. During postharvest storage, maize grains are vulnerable to many insects. Among those, Angoumois grain moth *Sitotroga cerealella* (Olivier), lesser grain borer *Rhyzopertha dominica*, weevils complex *Sitophlilus* spp., Khapra beetle, *Trogoderma granarium* Everts and red flour beetle, *Tribolium castaneum* (Herbst) are important (Ebeling, 2002) [2]. It is estimated that 5 to 10 percent of world's grain production is lost due to ravages of insect pests. These losses reach to 50 percent in tropical countries where temperature and humidity run high during summer season (Ahmad and Ahmad, 2002) [1]. The lesser grain borer, *R. dominica* Fab., is most injurious to stored grains having an important position among the storage pests. Control of insects by insecticides has serious drawbacks. Among various grain protectants, some plants have been found to possess the most effective and most acceptable active ingredients (Grainge and Ahmed, 1988) [5]. There is a need to develop pest control strategies which will be commercial and eco-friendly in small and large scale storages. These strategies could be achieved by exploiting the plants of insecticidal value, which are also easily available to farmers. Keeping this in view the investigations were carried on efficacy of different botanicals for the management of *R. dominica* in stored maize.

Material and methods
This experiment was conducted in the Department of Agricultural Entomology, College of Agriculture, Shivamogga during 2017-18. Maize seeds of Nithyashree variety were collected from the Zonal Agricultural and Horticulture Research Station, Shivamogga. Various selected seed protectants were evaluated for bioefficacy against *R. dominica* in maize seeds. The following seed protectants were included in the present study.

Rhizomes and leaves

Rhizomes of sweet flag *Acorus calamus* L. were procured from local market shivmogga and made into bits and shade dried for a week then ground into powder. The leaves of chrysanthemum (*Chrysanthemum sp* L.), thulasi (*Oscimum basilium* L.), custard apple (*Annona squamosa L.*), tobacco (*Nicotiana tobaccum* L.), Lantana (*Lantana camara*) were collected and shade dried for a week then ground into powder.

Seeds and Dry fruit chilli

Seeds of Jatropa, *Jatropa cuaracus* and dry fruit chilli, *Capsicum annuvum*, were collected and made into powder using a grinder.

Preparation of animal origin bio-products

Dry cow dung pallets and Goat dung pallets were collected from the farm house and dried for one week then ground into powder and burnt to get the cow dung ash. Cow urine was collected from the farm house.

Each of the grain protectant at the desired dosage was thoroughly mixed with 1.8 kg of freshly harvested seeds having high germination and low moisture content. The seed will be kept in hot air oven for a period of six hours at 42^0 c in order to eliminate the insect pests. Each of the seed protectants at the desired dosage were taken for proper treatment of the seed.

After seed treatment, seeds were kept in 2.5 kg cloth bag in the laboratory. From such cloth bag 100 g of seeds were drawn at monthly interval and kept in cloth bag of 250 g capacity. Twenty adults of freshly emerged 7 days old weevils were drawn from stock culture and released into each cloth bag and tightly fixed with rubber band. (3 replications were maintained). In this way at monthly interval for a period of six months were released. The observation on percent damaged seeds, percent weight loss and germination percentage was recorded at 30, 60, 90 and 180 days after storage. The observations were also recorded on the mortality of beetles at 7, 15 and 30 days after release (DAR) and 0, 30, 60, 90, 120, 150 and 180 days after treatment (DAT).

Results and discussion

Adult mortality

Among all the indigenous bio products evaluated for their efficacy over 180 days of maize storage significant difference was observed. Significantly higher percent mortality was recorded in *A. calamus* rhizome powder @ 2 percent (95.56%) followed by *A. squamosa* @ 2 percent (94.44%) and cow dung ash powder @ 2 percent (93.89%) respectively. The standard check malathion 5 percent D @ 2 percent recorded cent percent mortality of *R. dominica* when compare to other treatments. Whereas, lowest percent mortality was recorded in control check (3.33%) at 1DAT (table 1). At 30 DAT the significantly higher percent mortality was recorded in *A. calamus* rhizome powder @ 2 percent (95.00%) which was on par with *A. squamosa* @ 2 percent (93.33%) and cow dung ash powder @ 2 percent (90.56%) respectively. However, the lowest percent mortality was recorded in control check (3.33%). The similar trend was observed at 60 DAT, 90 DAT, 120 DAT and 150 DAT. Whereas, significantly higher percent mortality was recorded in *A. calamus* rhizome powder @ 2 percent (91.11%) which was on par with the treatments *A. squamosa* @ 2 percent (86.67%) and cow dung ash powder @ 2 percent (85.00%). Whereas, the lowest percent mortality was recorded in control check (3.33%) for a storage period of 180 days after treatment (table 1).

Seed damage and weight loss

Among different botanicals evaluated, the seeds treated with *A. calamus* rhizome powder @ 2 percent was recorded significantly lowest seed damage (1.75%) and weight loss (0.45%) followed by *A. squamosa* seed powder @ 2 percent and cow dung ash powder @ 2 percent with seed damage of 3.58 and 5.92 percent along with seed weight loss of 0.68 and 0.91 percent respectively. while significantly maximum seed damage was observed in untreated check (22.42%) with maximum seed weight loss of 23.95 percent followed by cow urine @ 2 percent with a seed damage of 18.67% along with a seed weight loss of 9.20 percent at 30 days after treatment. Similar trend was observed during 60 and 90 days after treatment. After 180 days of treatment imposition similar trend was observed; *A. calamus* rhizome powder @ 2 percent recorded minimum damage (6.17%) along with minimum weight loss of 0.88 percent followed by *A. squamosa* seed powder @ 5 percent with seed damage (10.67%), cow dung ash powder @ 2 percent (14.67%) and they were recorded with weight loss of 0.95 and 2.30 percent respectively. Significantly minimum seed damage (3.67%) was recorded in standard check malathion 5% D along with a significantly minimum weight loss of 0.76%. While significantly maximum seed damage was observed in untreated check (66.58%) with a weight loss of 74.39 percent followed by cow urine @ 2 percent seed damage (54.08%) and weight loss (29.42%) at 180 days after treatment (table 2 and 3).

Seed moisture

Significant differences were observed among the treatments with respect to seed moisture content observed 30, 60, 90 and 180 days after treatment imposition. The least seed moisture content was documented in *A. calamus* rhizome powder @ 2 percent (10.06%) treatment and *A. squamosa* powder @ 2 percent (10.09%) followed by cow dung ash powder @ 2 percent (10.12%) and the highest in untreated control (10.31%) and standard check malathion 5 D @ 2 percent (10.04%) recorded the least moisture content at 30 days after treatment imposition (table 4). Same trend was observed during 60 and 90 days after treatment. After 180 days of treatment *A. calamus* rhizome powder 2 percent (11.07%) followed by *A. squamosa* powder 2 percent (11.19%) and cow dung ash powder @ 2 percent (11.26%) and standard check malathion 5 D @ 2 percent (10.98%) recorded the least moisture and the highest in untreated control (12.05%). (Table 30). These findings are in agreement with Maheshbabu and Ravi (2008) The results revealed that seed treatment with sweet flag rhizome powder @ 10 g kg^{-1} treated seeds recorded significantly lowest moisture content of seed (9.10%) at end of seven months of storage period. compared to control (9.69%) (Table 4).

Seed germination

At 30 days after treatment, the seed germination percentage was significantly maximum (91.67%) in treatment *A. calamus* rhizome powder 2 percent followed by *A. squamosa* seed powder @ 2 percent and cow dung ash powder @ 2 percent with 90.00 and 89.33 percent germination respectively and did not differ significantly from each other. While, significantly minimum germination was recorded in untreated check (64.33%) followed by cow urine @ 2 percent (68.33%). Similar trend was observed during 60 and 90 days after treatment. At 180 days after treatment, *A. calamus* rhizome powder 2 percent, malathion 5 D @ 2 percent and *A.*

squamosa powder 2 percent retained significantly the maximum seed germination of 76.67, 75.00 and 74.33 percent respectively followed by cow dung ash powder @ 2 percent (72.00%) and *C. annuum* @ 2 percent (70.33%). Significantly the minimum percent germination was noticed in untreated check (45.67%) followed by cow urine @ 2 percent (49.67%) (Table 5).

The results of the present findings are agreement with the results of Kudachi and Balikai (2009) [10] who reported that *A. calamus* rhizome powder @ 1 percent recorded cent percent adult mortality of *R. dominica* with zero percent seed damage, minimum percent seed weight loss of zero percent and maximum germination percentage of 78.67 percent followed by *A. squamosa* @ 5 percent recorded 88.33 percent adult mortality, minimum seed damage (4.00%), less weight loss (2.36%) and maximum germination percentage of 70.67 per at 180 days after treatment. Jilani (1984) [7] who reported that *A. calamus* at 0.25, 0.5 and 1.0 percent caused, cent percent mortality of *R. dominica* in wheat seeds and also in conformity with Yadav (1971) [15], Shivanna (1988) [14] and Kittur (1990) [9] on various insects in different stored seeds. This may be due to strong ovicidal effects as reported by Shivanna (1988) [14] and Kittur (1990) [9]. Whereas, as per the report of Kalasagond (1998) [8] custard seed powder @ 1.4% caused 60.00 percent adult mortality of *R. dominica* at 180 days after storage and also minimum seed weight loss of 1.43 percent. This might be due to antifeedant effect of custard apple seed powder as reported by Luca (1979) [11]. Oni, 2011 [12] who reported that cow dung ash @ 5.00 gm exhibited 10. 40 percent adult mortality of *S. zeamais* after 48 hours. The effect of the ash is caused by a mechanical rather than by a chemical action. The ash hinders adult movement and thus hampers oviposition (Boeke *et al.*, 2003) [3].

Table 1: Adult mortality of lesser grain borer, *R. dominica* influenced by different botanicals and animal origin bio-products

Treatments		Part	Dosage (%) (w/w)	Percent adult mortality						
				1 DAT	**30 DAT**	**60 DAT**	**90DAT**	**120 DAT**	**150 DAT**	**180 DAT**
T_1	*Chrysanthemum* spp L.	Leaves	2	83.89 (66.64)$^{d-f}$	81.11 (64.52)$^{d-f}$	78.33 (62.56)$^{e-g}$	75.56 (60.49)^{ef}	73.89 (59.38)^{de}	71.67 (57.92)^{de}	65.56 (54.14)$^{d-f}$
T_2	*Oscimum basilium* L.	Leaves	2	80.56 (64.22)$^{d-f}$	78.33 (62.62)$^{d-f}$	75.00 (60.20)$^{e-g}$	72.22 (58.32)^{ef}	70.56 (57.25)^{de}	67.22 (55.14)^{de}	58.89 (50.15)$^{d-f}$
T_3	*Annona squamosa* L.	Seeds	2	94.44 (78.11)^{bc}	93.33 (76.19)^{bc}	92.78 (76.53)^{bc}	90.56 (73.58)^{bc}	88.89 (72.07)^{ab}	87.22 (69.60)^{ab}	86.67 (69.22)^{ab}
T_4	*Nicotiana tobaccum* L.	Leaves	2	87.22 (69.73)$^{c-e}$	85.00 (67.64)^{cde}	82.22 (65.32)$^{d-f}$	78.89 (62.94)$^{d-f}$	76.11 (60.88)$^{c-e}$	72.78 (58.76)^{cde}	71.11 (57.66)^{d}
T_5	*Lantana camara* L.	Leaves	2	80.00 (63.68)$^{d-f}$	75.56 (60.70)$^{d-f}$	69.44 (56.76)^{fg}	70.56 (57.30)^{ef}	68.89 (56.23)^{de}	65.56 (54.12)^{de}	56.67 (48.85)$^{d-f}$
T_6	*Acorus calamus* L.	Rhizome	2	95.56 (80.98)^{ab}	95.00 (79.55)^{b}	93.89 (77.5)^{b}	92.78 (76.40)^{b}	92.22 (75.10)^{a}	91.67 (75.44)^{a}	91.11 (74.82)^{ab}
T_7	*Jatropha cuaracus* L.	Seeds	2	86.11 (68.73)$^{c-e}$	83.89 (66.83)$^{c-f}$	81.11 (64.45)$^{d-g}$	77.22 (61.72)^{ef}	75.00 (60.23)^{de}	72.22 (58.37)^{de}	69.44 (56.54)^{de}
T_8	*Capsicum annuum* L.	Dry fruit	2	90.56 (73.39)$^{b-d}$	87.78 (70.15)$^{b-d}$	84.44 (67.25)$^{c-e}$	81.67 (65.13)$^{c-e}$	80.00 (63.87)$^{b-d}$	76.11 (61.04)$^{b-d}$	71.67 (58.04)^{cd}
T_9	Cow dung powder	-	2	82.22 (65.36)$^{d-f}$	78.89 (62.81)$^{d-f}$	76.67 (61.30)$^{e-g}$	72.78 (58.68)^{ef}	70.56 (57.22)^{de}	68.89 (56.17)^{de}	63.89 (53.12)$^{d-f}$
T_{10}	Cow urine	-	2	71.67 (57.99)^{f}	69.44 (56.66)^{f}	67.22 (55.29)^{g}	65.00 (53.93)^{f}	61.11 (51.58)^{e}	56.67 (48.89)^{e}	50.56 (45.32)^{f}
T_{11}	Cow dung ash powder	-	2	93.89 (76.68)^{bc}	92.78 (75.58)^{bc}	91.11 (74.00)$^{b-d}$	90.00 (71.95)$^{b-d}$	87.78 (70.31)$^{a-c}$	86.11 (68.94)^{abc}	85.00 (67.60)^{ab}
T_{12}	Goat dung	-	2	78.33 (62.48)^{ef}	73.89 (59.57)^{ef}	70.00 (56.97)^{fg}	65.56 (54.23)^{f}	64.44 (53.52)^{e}	61.67 (51.84)^{de}	54.44 (47.56)^{ef}
T_{13}	Malathion 5% D	-	2	100.00 (90.00)^{a}	100.00 (90.00)^{a}	100.00 (90.00)^{a}	100.00 (90.00)^{a}	93.89 (77.50)^{a}	90.00 (73.16)^{a}	84.44 (67.45)^{bc}
T_{14}	Control	-		3.33 (8.61)^{g}	3.33 (8.61)^{g}	3.89 (10.05)^{h}	0.56 (1.44)^{g}	1.67 (4.31)^{f}	3.33 (8.61)^{f}	3.33 (8.61)^{g}
S.Em±				3.37	3.54	3.42	3.16	3.38	3.52	3.36
CD (P = 0.05)				9.75	10.27	9.91	9.16	9.80	10.20	9.75
CV (%)				8.81	9.54	9.45	9.06	10.01	10.70	10.49

DAT – Days after treatment, DAR – Days after release

Figures in parentheses are arcsine transformed values Means in the columns followed by the same alphabet do not differ significantly by DMRT (P=0.05%)

Table 2: Percent seed damage influenced by botanicals for management of *R. dominica*

Treatments		Dosage (%) (w/w)	Seed damage (%)			
			30 DAT	60 DAT	90 DAT	180 DAT
T_1	*Chrysanthemum* spp L.	2	13.42 (21.49)^{e}	16.67 (24.09)^{e}	22.92 (28.60)^{e}	41.83 (40.30)^{g}
T_2	*Oscimum basilium* L.	2	14.58 (22.45)^{d}	18.58 (25.53)^{d}	24.92 (29.94)^{d}	44.83 (42.03)^{e}
T_3	*Annona squamosa* L.	2	3.58 (10.91)^{i}	4.92 (12.81)^{i}	6.50 (14.76)^{i}	10.67 (19.06)^{l}
T_4	*Nicotiana tobaccum* L.	2	9.00 (17.46)^{g}	11.58 (19.87)^{g}	17.08 (24.40)^{g}	29.00 (32.58)^{i}
T_5	*Lantana camara* L.	2	16.58 (24.03)^{c}	20.25 (26.74)^{c}	27.92 (31.89)^{c}	50.42 (45.24)^{d}
T_6	*Acorus calamus* L.	2	1.75 (7.60)^{j}	2.25 (8.63)^{j}	3.42 (10.65)^{j}	6.17 (14.38)^{m}
T_7	*Jatropha cuaracus* L.	2	11.17 (19.52)^{f}	13.92 (21.90)^{f}	19.83 (26.45)^{f}	36.17 (36.97)^{h}
T_8	*Capsicum annuum* L.	2	6.33 (14.58)^{h}	8.33 (16.75)^{h}	11.00 (19.37)^{h}	17.75 (24.92)^{j}
T_9	Cow dung powder	2	14.00 (21.97)^{de}	17.33 (24.60)^{de}	23.75 (29.17)^{de}	43.42 (41.22)^{f}
T_{10}	Cow urine	2	18.67 (25.60)^{b}	23.00 (28.66)^{b}	31.75 (34.29)^{b}	54.08 (47.34)^{b}
T_{11}	Cow dung ash powder	2	5.92 (14.07)^{h}	7.50 (15.89)^{h}	9.08 (17.52)^{i}	14.67 (22.52)^{k}
T_{12}	Goat dung powder	2	16.92 (24.28)^{c}	21.08 (27.33)^{c}	29.33 (32.79)^{c}	52.17 (46.24)^{c}
T_{13}	Malathion 5% D	2	0.92 (5.45)^{k}	1.33 (6.62)^{k}	2.17 (8.43)^{k}	3.67 (11.04)^{n}
T_{14}	Control	-	22.42 (28.26)^{a}	30.67 (33.63)^{a}	36.08 (36.92)^{a}	66.58 (54.69)^{a}
S.Em±			0.24	0.33	0.40	0.10
CD (P = 0.05)			0.68	0.96	1.15	0.28
CV (%)			2.22	2.74	2.79	2.10

Figures in parentheses are arcsine transformed values
Means in the columns followed by the same alphabet do not differ significantly

Table 3: Effect of botanicals and animal origin bio-products on maize seed weight loss (%) due to *R. dominica* under laboratory conditions

Treatments		Dosage (%) (w/w)	Weight loss (%)			
			30 DAT	60 DAT	90 DAT	180 DAT
T_1	*Chrysanthemum* spp L.	2	4.25 (11.89)^{e}	5.13 (13.09)^{g}	6.14 (14.35)^{g}	15.34 (23.06)^{g}
T_2	*Oscimum basilium* L.	2	6.12 (14.33)^{c}	6.56 (14.84)^{e}	7.42 (15.80)^{e}	17.74 (24.91)^{e}
T_3	*Annona squamosa L.*	2	0.68 (4.71)^{i}	0.89 (5.42)^{l}	0.96 (5.62)^{l}	0.95 (5.58)^{l}
T_4	*Nicotiana tobaccum* L.	2	2.57 (9.21)^{g}	3.93 (11.43)^{i}	4.50 (12.25)^{i}	13.43 (21.50)^{i}
T_5	*Lantana camara* L.	2	6.33 (14.57)^{c}	7.26 (15.63)^{d}	7.93 (16.36)^{d}	22.57 (28.36)^{d}
T_6	*Acorus calamus* L.	2	0.45 (3.68)^{j}	0.80 (5.13)^{m}	0.87 (5.34)^{l}	0.88 (5.37)^{lm}
T_7	*Jatropha cuaracus* L.	2	3.20 (10.30)^{f}	4.75 (12.58)^{h}	5.10 (13.05)^{h}	14.32 (22.24)^{h}
T_8	*Capsicum annuum* L.	2	2.10 (8.33)^{h}	3.62 (10.97)^{j}	4.14 (11.75)^{j}	12.35 (20.57)^{j}
T_9	Cow dung powder	2	5.30 (13.31)^{d}	5.75 (13.88)^{f}	6.57 (14.85)^{f}	16.73 (24.14)^{f}
T_{10}	Cow urine	2	9.20 (17.65)^{b}	9.91 (18.35)^{b}	10.51 (18.91)^{b}	29.42 (32.85)^{b}
T_{11}	Cow dung ash powder	2	0.91 (5.48)^{i}	1.06 (5.90)^{k}	1.09 (5.98)^{k}	2.30 (8.70)^{k}
T_{12}	Goat dung powder	2	6.62 (14.91)^{c}	7.59 (15.99)^{c}	8.51 (16.97)^{c}	26.26 (30.83)^{c}
T_{13}	Malathion 5% D	2	0.09 (1.58)^{k}	0.44 (3.79)^{n}	0.63 (4.55)^{m}	0.76 (5.00)^{m}
T_{14}	Control	-	23.95 (29.30)^{a}	26.47 (30.96)^{a}	29.36 (32.81)^{a}	74.39 (59.60)^{a}
S.Em±			0.28	0.09	0.12	0.14
CD (P = 0.05)			0.80	0.25	0.36	0.55
CV (%)			2.70	1.17	1.49	1.09

Figures in parentheses are arcsine transformed values
Means in the columns followed by the same alphabet do not differ significantly

Table 4: Effect of botanicals and animal origin bio-produc

Treatments		Dosage (%) (w/w)	Moisture content (%)			
			30 DAT	60 DAT	90 DAT	180 DAT
T_1	*Chrysanthemum* spp L.	2	10.21^{c-e}	10.29^{d-g}	10.63^{c-e}	11.61^{ef}
T_2	*Oscimum basilium* L.	2	10.24^{b-d}	10.32^{c-e}	10.66^{b-e}	11.76^{cd}
T_3	*Annona squamosa* L.	2	10.09^{gh}	10.14^{h}	10.51^{ef}	11.19^{i}
T_4	*Nicotiana tobaccum* L.	2	10.18^{e}	10.25^{fg}	10.58^{d-f}	11.45^{gh}
T_5	*Lantana camara* L.	2	10.25^{b-d}	10.35^{cd}	10.71^{b-d}	11.79^{c}
T_6	*Acorus calamus* L.	2	10.06^{h}	10.12^{h}	10.48^{fg}	11.07^{j}
T_7	*Jatropha cuaracus* L.	2	10.19^{de}	10.26^{e-g}	10.61^{c-f}	11.53^{fg}
T_8	*Capsicum annuum* L.	2	10.17^{ef}	10.23^{g}	10.56^{ef}	11.39^{h}
T_9	Cow dung powder	2	10.22^{c-e}	10.31^{c-f}	10.64^{c-e}	11.68^{de}
T_{10}	Cow urine	2	10.29^{ab}	10.41^{ab}	10.79^{ab}	11.94^{b}
T_{11}	Cow dung ash powder	2	10.12^{fg}	10.16^{h}	10.53^{ef}	11.26^{i}
T_{12}	Goat dung powder	2	10.25^{a-c}	10.37^{bc}	10.75^{a-c}	11.84^{bc}
T_{13}	Malathion 5% D	2	10.04^{h}	10.09^{h}	10.35^{g}	10.98^{j}
T_{14}	Control	2	10.31^{a}	10.44^{a}	10.86^{a}	12.05^{a}
S.Em±			0.01	0.02	0.21	0.03
CD (P = 0.05)			0.05	0.06	0.14	0.10
CV (%)			0.32	0.38	0.83	0.52

Means followed by same alphabet in a column do not differ significantly; DAT: Days after treatment.

Table 5: Effect of botanicals and animal origin bio-products on germination of maize due to *R. dominica* at different storage period

Treatments		Dosage (%) (w/w)	Germination (%)			
			30 DAT	**60 DAT**	**90 DAT**	**180 DAT**
T_1	*Chrysanthemum* spp L.	2	80.00 (63.45)^{ef}	73.33 (58.96)^{fg}	70.67 (57.22)^{ef}	62.67 (52.34)^{fg}
T_2	*Oscimum basilium* L.	2	77.00 (61.35)^{gh}	68.67 (55.97)^{gh}	65.33 (53.94)^{gh}	58.00 (49.61)^{h}
T_3	*Annona squamosa* L.	2	90.00 (71.58)^{ab}	86.67 (68.64)^{ab}	82.00 (64.93)^{bc}	74.33 (59.57)^{ab}
T_4	*Nicotiana tobaccum* L.	2	84.00 (66.45)^{d}	78.67 (62.50)^{de}	75.33 (60.24)^{de}	68.67 (55.96)^{de}
T_5	*Lantana camara* L.	2	75.67 (60.45)^{h}	65.67 (54.14)^{hi}	62.67 (52.34)^{hi}	56.33 (48.64)^{hi}
T_6	*Acorus calamus* L.	2	91.67 (73.26)^{a}	88.67 (70.40)^{a}	86.33 (68.34)^{a}	76.67 (61.12)^{a}
T_7	*Jatropha cuaracus* L.	2	82.33 (65.16)^{de}	75.67 (60.46)^{ef}	73.33 (59.05)^{ef}	65.67 (54.13)^{ef}
T_8	*Capsicum annuum* L.	2	86.67 (68.60)^{c}	81.00 (64.18)^{cd}	78.33 (62.27)^{cd}	70.33 (57.00)^{cd}
T_9	Cow dung powder	2	79.33 (62.99)^{fg}	71.33 (57.66)^{fg}	69.67 (56.59)^{fg}	59.67 (50.58)^{gh}
T_{10}	Cow urine	2	68.33 (55.76)^{i}	58.00 (49.62)^{jk}	54.67 (47.68)^{jk}	49.67 (44.81)^{j}
T_{11}	Cow dung ash powder	2	88.33 (70.05)^{bc}	83.67 (66.19)^{bc}	80.33 (63.69)^{bc}	72.00 (58.07)^{bc}
T_{12}	Goat dung powder	2	70.00 (56.79)^{i}	61.33 (51.57)^{ij}	57.67 (49.42)^{ij}	53.33 (46.91)^{i}
T_{13}	Malathion 5% D	2	89.33 (70.94)^{b}	87.00 (68.9)^{ab}	84.00 (66.43)^{ab}	75.00 (60.03)^{ab}
T_{14}	Control	-	64.33 (53.33)^{j}	53.33 (46.92)^{k}	51.00 (45.57)^{k}	45.67 (42.51)^{k}
SEM±			0.68	1.18	1.08	0.70
CD(0.05)			1.97	3.43	3.13	2.02
CV			1.83	3.44	3.24	2.28

Figures in parentheses are arcsine transformed values

Means in the columns followed by the same alphabet do not differ significantly

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