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Study on the Efficacy of Botanicals on Seed Quality of Cowpea during Storage under Ambient Condition

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Abstract

An experiment was carried out to know the effect of seed treatment with botanicals on storability of cowpea seeds during 2015-16, 2016-17 and 2017-18 at Seed Technology Research Unit, National Seed Project, University of Agricultural Sciences, Bangalore. After proper drying, seeds were treated with different botanicals and stored them under ambient condition. The seeds treated with delata methrin 2.8EC@ 1 ppm and untreated seeds served as check and control, respectively. The results revealed that the seeds treated with botanicals were significantly superior over the seeds treated with chemical in controlling the storage insect pests and maintains higher seed quality throughout the storage period when compared to untreated control. The botanical neem formulation 10000ppm *Azadirachtin* @ 1.5ml/kg seed recorded significantly highest germination (81%) even after twelve months of storage with minimum seed moisture content (11.35%) and least seed infestation (1.75%). The treatment was found to be on par with botanical *Acorus calamus* formulation @10ml/kg (78, 11.76 and 2.08%) and deltamethrin 2.8EC@1ppm (77, 11.62 and 1.92%), respectively. The untreated control recorded the least germination (57%) and highest seed infestation (28.58%) with highest seed moisture content (12.23%) at the end of twelve months of storage. Among the botanicals, the cost benefit ratio was found to be highest (1:5.75) in Karanja (*Pongamia pinnata*) oil followed by the botanical neem formulation 10000ppm *Azadirachtin* @ 1.5ml/kg seed (1:4.86).

Keywords : Cowpea, Neem formulation 10000ppm *Azadirachtin*, *Acorus calamus* formulation, Botanical, Seed treatment, Benefit cost ratio

Pulses play an important role as the supplement of protein in the diet of the people. Cowpea is the important pulse crop grown in Karnataka in order to meet the domestic needs. India is one of the leading countries in pulse production with 23.7 million tonnes over an area of 34.62 million hectares at a productivity of 685 kg per ha (Singhal, 2003). Pulses contain 20-30 per cent of protein of which lysine is of great importance and serves as the best means of solving malnutrition problems in the pure vegetarian Indian diet. As a result, full yield potential of the cowpea crop is seldom realizes due to interaction of many factors of which post-harvest insect infestation and consequent damage is one of the most important. Seed quality is the pre requisite condition that affects the germination and yield of any crop plants. This condition is directly related with the various factors like moisture content, seed drying temperature, storage temperature, relative humidity of the storage environment, types of storage container and storage period. Recently, the use of different plant parts and their derivatives has appeared to be an effective alternative to poisonous chemical insecticides for controlling various insect pests in storage. In the world, as many as 2400 plant species have been recorded that have potential insecticidal properties and biological activity against a wide range of pests (Grainge and Ahmed, 1988). In storage, cowpea seeds deteriorate faster and affect its quality due to fungal, insect or other pest infestation. Different botanicals can be used for protection of seeds. Botanicals are less costly, easily available to the farmers and safe to handle. Comparative study of botanicals helps to choose the suitable one for storing the seeds of cowpea. The studies were carried out to determine the effects of four botanicals *viz.,* Neem formulation @10,000 ppm *Azadirachtin,*

Karanja (*Pongamia pinnata*) oil, Citronella oil and *Acorus calamus* formulation on the seed quality of cowpea.

Material and Methods

An experiment was carried out in the Seed Technology Research Unit, NSP, Bengaluru with six treatments by adopting completely randomized design (CRD) in three replications during the year 2015-16, 2016-17and 2017-18 for three consiquitive years. The data was pooled and the data obtained from the experiment was statistically analysed by using appropriate ANOVA with the suitable transformation wherever necessary. The treatments were :

T_1 = Neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg seed = 15mg /kg seed)

T_2 = Karanja *(Pongamia pinnata)* oil @ 5 ml/kg seed

T_3 = Citronella oil @ 5ml/kg of seed

T_4 = *Acorus calamus* formulation @10ml/kg

T_5 = Delatamethrin@1ppm (0.04ml/kg seed)

T_6 = Untreated control

Good quality freshly harvested certified seeds of Cowpea *vr*. KBC 9 (with germination of 95 per cent, moisture content (>9 per cent) and free off insect damage) were obtained from seed processing unit, National Seed Project and used for this experiment. The experiment was conducted in three consecutive years 2015-16, 2016-17 and 2017-18. Recommended quantities of delatamethrin 2.8EC @1 ppm and neem formulation @ 10000 ppm *Azadirachtin* botanicals were diluted in 5 ml of water separately to treat one kg of seed and remaining botanicals were directly treated to seeds for uniform coating and dried under shade. After treatment, seeds were packed in 2 kg capacity cloth bag and kept for storage under ambient condition maintained at 25^0C - 30^0C (temperature) and relative humidity of 70 per cent. The observations were recorded at tri-monthly interval up to twelve months.

The germination test was conducted by paper medium (between paper method) as prescribed by the International Seed Testing Association (ISTA, 2010). Germination counts were recorded on 8th day after incubation in germination chamber maintained at $25^+ 1^0$C with 95 per cent relative humidity.

Moisture content of seed was estimated by oven method by taking 5 grams of cowpea seeds from each replication and treatment. The seeds were grinded and kept in oven maintained at 103^0C (temperature) for 17 hours and final weight was recorded. The moisture content of seed was calculated byusing following formula.

$$\text{Moisture content (\%)} = \frac{W_2 - W_3}{W_2 - W_3} \times 100$$

Whereas,

W_1 = weight of empty cup with lid (g)

W_2 = weight of cup with seed samples before drying (g)

W_3 = weight of cup with seed sample after drying (g)

For per cent seed damage, four hundred seeds were randomly drawn from each treatment and replication, number of damaged seeds were counted and expressed as per cent seed infestation by using following formula.

$$\text{Per cent seed infestation} = \frac{\text{Number of seeds damaged}}{\text{Total number of seeds}} \times 100$$

Results and Discussion

The seed treatments with botanicals differed significantly with respect to germination, moisture content and insect damage. During 2015-16, the highest germination (90% each) was recorded with the treatments of Neem formulation 10000 ppm, Acorus calamus formulation and delta methrin 2.8 EC @ 1.0 ppm. Further, the highest germination 95 and 97 per cent was observed in neem formulation 10000 ppm @1.5ml/kg seed during 2016-17, 2017-18 which was on par with *Acorus calamus* formulation (93 and 96%) and delta methrin 2.8 EC @ 1.0 ppm (92 and 94%), respectively. The untreated control recorded the least germination (86, 86 and 88%) during 2015-16, 2016-17 and 2017-18, respectively. In the mean of three years the highest germination was observed in neem formulation @10000 ppm

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TABLE 1

Effect of botanicals as seed treatment on germination (%) of stored cowpea *vr*. KBC-9 during storage

Treatments	3 MAT				6 MAT				9 MAT				12 MAT			
	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*
T_1 : Neem formulation 10000 ppm @1.5ml/kg seed (=15mg *Azadirachtin*/kg seed)	90 (71.54)	95 (77.05)	97 (79.99)	94.00 [a] (76.19)	87 (68.84)	91 (72.51)	92 (73.54)	90.00 [a] (71.63)	83 (65.62)	87 (68.84)	86 (68.00)	85.00 [a] (64.49)	79 (62.70)	82 (64.87)	82 (64.87)	81.00 [a] (64.15)
T_2 : Karanja (*Pongamia pinnata*) oil @ 5 ml/kg seed	89 (70.60)	93 (74.63)	95 (77.05)	92.00 [ab] (74.09)	87 (68.84)	84 (66.40)	90 (71.54)	87.00 [a] (68.92)	80 (63.41)	82 (64.87)	83 (65.62)	82.00 [a] (64.63)	75 (59.98)	78 (62.00)	76 (60.64)	76.00 [b] (60.87)
T_3 : Citronella oil @ 5 ml/kg of seed	85 (67.19)	87 (68.84)	90 (71.54)	87.00[b] (69.19)	72 (58.03)	74 (59.32)	73 (58.67)	73.00[b] (58.67)	56 (48.43)	58 (49.58)	60 (50.75)	58.00[c] (49.59)	48 (43.84)	45 (42.11)	44 (41.54)	46.00[d] (42.50)
T_4 : *Acorus calamus* formulation @ 10 ml/kg	90 (71.54)	93 (74.63)	96 (78.43)	94.00[a] (75.67)	87 (68.84)	91 (72.51)	90 (71.54)	89.00[a] (70.96)	83 (65.62)	83 (65.62)	85 (67.19)	84.00[a] (66.14)	76 (60.64)	78 (62.00)	81 (64.13)	78.00[ab] (62.26)
T_5 : Deltamethrin 2.8 EC @ 1.0 ppm (0.04 ml/kg seed)	90 (71.54)	92 (73.54)	94 (75.79)	92.00[ab] (73.62)	87 (68.84)	87 (68.84)	88 (69.70)	88.00[a] (69.42)	80 (63.41)	83 (65.62)	82 (64.87)	82.00[a] (64.63)	76 (60.64)	78 (62.00)	78 (62.00)	77.00[a] (59.32)
T_6 : Untreated control (68.00)	86 (68.00)	86 (69.70)	88 (68.57)	87.00[b] (59.32)	74 (59.98)	75 (59.32)	74 (59.54)	74.00[b] (53.71)	65 (52.51)	63 (56.14)	69 (54.12)	66.00[b] (49.58)	58 (46.13)	52 (51.92)	62 (49.21)	57.00[c]
S.Em ±				1.10				1.17				1.15				1.53
CD (0.05P)				3.41				3.61				3.53				4.72
CV (%)				2.29				2.43				2.61				3.85

*Mean of three years; MAT- Months after treatment

Azadirachtin (1.5ml/kg) and *Acorus calamus* formulation @10ml/kg (94.00% each) followed bykaranja (*Pongamia pinnata*) oil @ 5 ml/kg and deltamethrin 2.8EC@1ppm (92.00% each) after three months of storage. Further, at six months of storage similar results were observed. The highest germination (91 and 92%) was observed in neem formulation 10000 ppm @1.5ml/kg seed during 2016-17, 2017-18, respectively. Followed by *Acorus calamus* formulation @10ml/ kg (91 and 90.00%, respectively). Untreated control recorded the least (75 and 74%) during 2016-17, 2017-18. The pooled data of three years recorded the highest germination (90%) in neem formulation 10000 ppm @1.5ml/kg seed. Which was on par with *Acorus calamus* formulation @10ml/kg (89%), delta methrin 2.8EC@1ppm (88%) and Karanja (*Pongamia pinnata*) oil @ 5 ml/ kg seed (87%). The least germination (74%) was observed in untreated control.

At nine months of storage, seeds treated with neem formulation @10000 ppm *Azadirachtin* recorded the highest germination (87 and 86%) during 2016-17 and 2017-18. Where, untreated control recorded the least germination (63 and 69%), respectively. In the mean of three years seeds treated with neem formulation @10000 ppm *Azadirachtin* recorded significantly highest germination (85%). Which was onpar with *Acorus calamus* formulation @10ml/ kg (84%), Karanja (*Pongamia pinnata*) oil @ 5 ml/kg seed and deltamethrin 2.8EC (82% each). Further, untreated control was observed the least germination (66%).

After twelve months of storage similar observations were noticed, the highest germination was recorded in the neem formulation @10000 ppm *Azadirachtin* (82% each) *during* 2016-17 and 2017-18, respectively. The untreated control recorded the least germination (52 and 62%), respectively. In the mean of three years significantly highest germination (81%) was recorded the seeds treated with neem formulation @10000 ppm *Azadirachtin,* which differed significantly over all other treatments, which was on par with *Acorus calamus* formulation @10ml/kg (78%) and deltamethrin 2.8EC @1ppm (77%). However, the untreated control recorded least germination (57%) which was found to be inferior over all other treatments (Table 1). This indicates that botanicals are helpful in maintaining the seed quality and performing equally with the deltamethrin. The highest germination after twelve months of storage was observed in botanicals may be due to insect repellent properties resulted in less damage of seed embryo. These findings were in conformity with the results of Channabasanagowda *et al.* (2008) on wheat, Mahesh babu and Ravi hunje (2008) on soybean.

Seed moisture during 2015-16, 2016-17 and 2017-18 recorded non-significant results. Further the mean of three years also observed non-significant results with respect to seed moisture content after three months of storage. However, the minimum seed moisture content (8.32%) was recorded in the seeds treated with Karanja (*Pongamia pinnata*) oil @ 5ml/kg followed by neem formulation 10000 ppm @1.5ml/kg seed (8.36%). After six months of storage, during 2015-16 and 2017-18 the least seed moisture was observed least (9.62%) with Karanja (*Pongamia pinnata*) oil @ 5 ml/kg. The highest seed moisture was recorded in untreated control (10.92 and 10.54%), respectively. In the mean of three years least seed moisture content was observed in the seeds treated with Karanja (*Pongamia pinnata*) oil @ 5 ml/kg (9.68%) which was on par with all other treatments and differed significantly over untreated control which showed highest (10.75%) seed moisture content. The seed moisture content after nine months of storage also recorded similar results. The least seed moisture content (10.65%) was observed in Karanja (*Pongamia pinnata*) oil @ 5 ml/kg in the mean of three years. However, untreated control recorded the highest seed moisture (11.59%). Further, after twelve months of storage the seed moisture content of 11.23 per cent was noticed in the seeds treated with Karanja (*Pongamia pinnata*) oil @ 5 ml/kg (11.23%) which was on par with neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg) (11.35%) both of them differed significantly over all other treatments. The untreated control recorded the highest seed moisture content (12.23%) which showed inferior to all other

TABLE 2

Effect of botanicals as seed treatment on per cent moisture content of stored cowpea *vr.* KBC-9 during storage

Treatments	3 MAT				6 MAT				9 MAT				12 MAT			
	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*
T_1 : Neem formulation 10000 ppm @1.5ml/kg seed (=15mg azadirachtin/kg seed)	8.50	8.37	8.21	8.36	9.50	10.25	9.80	9.85^{a}	10.82	10.62	10.75	10.73^{ab}	11.50	11.35	11.20	11.35^{ab}
T_2 : Karanja (Pongamia pinnata) oil @ 5 ml/kg seed	8.45	8.32	8.20	8.32	9.62	9.80	9.62	9.68^{a}	10.81	10.70	10.43	10.65^{a}	10.90	11.40	11.40	11.23^{a}
T_3 : Citronella oil @ 5 ml/kg of seed	8.80	8.52	8.39	8.57	9.90	10.50	9.55	9.98^{a}	10.78	11.60	10.58	10.99^{ab}	11.80	11.45	12.25	11.83^{bc}
T_4 : Acorus calamus formulation @ 10 ml/kg	8.62	8.52	8.23	8.46	9.70	10.20	9.75	9.88^{a}	10.79	11.00	10.58	10.79^{ab}	11.89	11.65	11.75	11.76^{abc}
T_5 : Deltamethrin 2.8 EC @ 1.0 ppm (0.04 ml/kg seed)	8.57	8.80	8.34	8.57	9.80	10.10	9.90	9.93^{a}	10.85	10.65	10.50	10.67^{bc}	11.89	12.50	11.48	11.62^{c}
T_6 : Untreated control	8.50	8.25	8.68	8.48	10.92	10.78	10.54	10.75^{b}	11.80	11.50	11.47	11.59^{c}	11.90	12.40	12.40	12.23^{c}
S.Em ±				0.11				0.17				0.16				0.15
CD (0.05P)				NS				0.52				0.49				0.47
CV (%)				2.27				2.94				2.51				2.26

*Mean of three years; MAT- Months after treatment; NS- Non significant

TABLE 3

Effect of botanicals as seed treatment on seed infestation (%) of stored cowpea *vr*. KBC-9 during storage.

Treatments	3 MAT				6 MAT				9 MAT				12 MAT			
	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*	2015-16	2016-17	2017-18	Mean*
T1:Neem formulation 10000 ppm @1.5ml/kg seed (=15mg azadirachtin/kg seed)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.25 (2.86)	0.00 (0.00)	0.25 (2.86)	0.17^{a} (1.91)	1.00 (5.74)	1.25 (6.42)	0.75 (4.97)	1.00^{a} (5.71)	1.75 (7.60)	2.00 (8.13)	1.50 (7.60)	1.75^{a} (7.59)
T2:Karanja (Pongamia pinnata) oil @ 5 ml/kg seed	0.00 (0.00)	0.25 (2.86)	0.00 (0.00)	0.08 (0.95)	0.50 (4.05)	0.25 (2.86)	0.50 (4.05)	0.42^{ab} (3.66)	1.25 (6.42)	1.75 (7.60)	2.00 (8.13)	1.67^{a} (7.38)	3.25 (11.89)	3.75 (12.58)	3.50 (13.56)	3.50^{bc} (10.77)
T3:Citronella oil @ 5 ml/kg of seed	0.25 (2.86)	0.00 (0.00)	0.00 (0.00)	0.08 (0.95)	0.50 (4.05)	0.50 (4.05)	0.75 (4.97)	0.58^{ab} (4.36)	1.25 (6.42)	1.75 (7.60)	2.25 (8.62)	1.75^{a} (7.55)	3.25 (10.38)	3.00 (9.97)	4.75 (12.58)	3.67b (10.98)
T4:Acorus calamus formulation @ 10 ml/kg	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.25 (2.86)	0.25 (2.86)	0.25 (2.86)	0.25^{a} (2.86)	1.75 (7.60)	1.25 (6.42)	1.50 (7.03)	1.50^{a} (7.02)	1.75 (7.60)	2.00 (8.13)	2.50 (9.09)	2.08^{a} (8.27)
T5: Deltamethrin 2.8 EC @ 1.0 ppm (0.04 ml/kg seed)	0.25 (2.86)	0.00 (0.00)	0.25 (2.86)	0.17 (1.91)	0.75 (4.97)	1.00 (5.74)	0.75 (4.97)	0.83^{b} (5.22)	1.75 (7.60)	2.25 (8.62)	1.50 (7.03)	1.83^{a} (7.75)	1.50 (13.24)	2.25 (13.87)	2.00 (14.47)	1.92^{a} (7.93)
T6 :Untreated control	1.75 (7.60)	1.00 (5.74)	1.25 (6.42)	1.33 (6.58)	4.00 (12.58)	5.25 (13.24)	4.75 (11.53)	4.67^{c} (12.45)	11.75 (21.34)	12.00 (20.26)	13.25 (20.04)	12.33^{b} (20.55)	27.50 (31.62)	30.00 (32.20)	28.25 (32.09)	28.58^{d} (32.30)
S.Em ±								0.16				0.27				0.40
CD (0.05P)				NA				0.50				0.83				1.25
CV (%)								24.51				13.97				10.50

*Mean of three years; MAT- Months after treatment; NA- Not analysed

treatments (Table 2). Similar results were reported by Mahesh Babu and Ravi Hunje (2008) in soybean.

No seed infestation was observed during 2015-16, 2016-17 and 2017-18 with seed treatment of neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg). In the mean of three years, no seed infestation was observed with neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg) and *Acorus calamus* formulation @10ml/kg seed treatment after three months of storage. The highest seed infestation (1.33%) was in untreated control seeds. It might be due to their repellent and ovicidal properties (Merwade, 2000). After six months of storage, neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg) recorded the least seed infestation during 2015-16, 2016-17 and 2017-18 (0.25, 0.00 and 0.25%, respectively). In the mean of three years, seeds treated with neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg) recorded least (0.17%) seed infestation which was on par with *Acorus calamus* formulation @10ml/kg (0.25%) and significantly highest in untreated control (4.67%). At nine months of storage, similar results were observed, the least seed infestation was observed in neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg) during 2015-16, 2016-17 and 2017-18 (1.00, 1.25 and 0.75%), respectively. In the mean of three years significantly least (1.00%) seed infestation was recorded in neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg) treated seeds which was on par with all other treatments. However, untreated control recorded the highest (12.33%) seed infestation. After twelve months of storage in the mean of three years, the seed infestation was significantly least (1.75%) in neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg) which was on par with delatametrin 2.8EC@1ppm (1.92%) and *Acorus calamus* formulation (2.08%). Untreated control recorded the highest (28.58%) seed infestation. The seeds treated with botanicals namely neem formulation @10000ppm (1.5ml/kg seed) and *Acorus calamus* formulation 10ml/kg were found to be oil based and recorded lower seed infestation percentage indicating the possibility of use of these botanicals in controlling the insect infestation. Similar results were observed on storability of wheat (Channabasanagowda *et al*., 2008). Further, untreated control recorded highest (28.58%) seed infestation which was significantly inferior to all other treatments (Table 3). Although the use of chemical insecticides, delta methrin 2.8EC continues to be the effective method of controlling stored insect pests, neem

TABLE 4

Cost Benefit ratio for adopting botanicals as seed treatment on stored cowpea *vr*. KBC-9 during storage

Treatments	Dosage / kg	Quantity for 100 kg	Total Cost * for 100 kg	Damage %	Loss due to damage @ 85/kg (Rs)	Total loss per qtl (Rs)	B:C
T_1 : Neem formulation 10000 ppm @1.5ml/kg seed (=15mg A*zadirachtin*/kg seed)	1.5ml	150 ml	350	1.75	149	499	4.86
T_2 : Karanja (*Pongamia pinnata*) oil @ 5 ml/kg seed	5ml	500 ml	125	3.50	297	422	5.75
T_3 : Citronella oil @ 5 ml/kg of seed	5 ml	500 ml	550	3.67	312	862	2.81
T_4: *Acorus calamus* formulation @ 10 ml/kg	10 ml	1000 ml	2050	2.08	177	2227	1.09
T_5: Deltamethrin 2.8 EC @ 1.0 ppm (0.04 ml/kg seed)	0.04ml	4ml	55	1.92	163	218	11.14
T_6: Untreated control			0	28.58	2429	2429	

*Cost of chemicals + labour cost

materials, such as neem formulation @ 10000 ppm can be used economically to achieve acceptable levels of insect control.

Cost benefit ratio was also calculated to find out the most effective treatment for storage of cowpea for farming community. The highest cost benefit ratio of 11.14 was in delta metrin 2.8EC @1ppm treated seed. Among the botanicals, the highest cost benefit ratio of 1:5.75 was recorded in Karanja (*Pongamia pinnata*) oil @ 5 ml/kg seed and the next best treatment was seed treated with neem formulation @ 10000 ppm *Azadirachtin* (1.5ml/kg), (1:4.86) (Table 4). Similar results with respect to benefit cost ratio of delta metrin 2.8EC @1ppm was observed on cowpea by Thirumala Raju and Jyothi, 2016.

Based on the present findings, it can be concluded that there is a great scope for using botanicals like neem formulation @10000 ppm *Azadirachtin* and Karanja (*Pongamia pinnata*) oil which gave equal effectiveness of chemical deltamethrin 2.8EC in protecting the cowpea seeds during storage. Use of botanicals for seed treatment is advisable because of their safety to human health. The botanicals also as same insecticidal property as that of insecticides delata methrin 2.8EC and can maintain the viability and vigour of seed for long period. The main advantage of treating seeds with botanicals over chemicals is that, if any quantity of the seeds treated with botanicals left, it could be used for consumption purpose after proper washing with water, whereas, it could not be possible in seeds treated with chemicals which has residual toxicity on the human beings and animals.

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