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Performance of neem products on the storability of mungbean [*Vigna radiata* (L.) Wilczek] seeds

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ABSTRACT

The present investigation was carried out in laboratory of the Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh from August, 2013 to June, 2015, wherein two kg of freshly harvested quality seed of mungbean cv. GM 4 having high germination percentage and low moisture content (below 8%) was taken for each repetition and given the treatments. The experiment was carried out using completely randomized design (CRD). After proper mixing or smearing, seeds were packed in 500 gauge polythene bags and kept in laboratory under ambient condition. Observations were recorded at bimonthly interval on germination (%), root length (cm), shoot length (cm), seedling dry weight (g), seed vigour index I, seed vigour index II and seed moisture content (%). The results indicated that all the treatments exhibited significant difference for all the traits studied except shoot length after two years of storage. The Indian Minimum Seed Certification Standards in mungbean for germination percentage is 75 per cent. Looking to the germination percentage and Seed vigourindex I and II, among all the treatments, T_1 (Neem Seed kernel powder @ 5 g/kg seed), T_2 (Neem seed kernel powder @ 10 g/kg seed), T_3 (Neem Cake @ 5g/kg Seed) and T_4 (Neem Cake @ 10g/kg Seed) recorded the higher values for these traits and can be recommended as a seed treatment before storage for maintaining the seed germination and seedling vigour for more than two years.

Key words: Mungbean, Neem products, Storability.

INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] is native to India and is cultivated since ancient times. It is a fast growing warm season dry land legume crop with short growing season. This crop plays a crucial role not only in human diet, but also in improving the soil fertility by fixing atmospheric nitrogen with the help of *Rhizobium* present in root nodules (Ashraf and Shahbaz, 2003). During 2013-14, It is grown on about 3.38 million ha in the country with a production of 1.61 million tones and productivity of 474 kg/ha mainly in Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Orissa and Bihar (Anonymous, 2016a). The area has increased from 1.99 million ha in 1964-65 to 3.38 million ha in 2013-2014. The production has increased from 0.60 million tonnes to 1.61 million tonnes during the same period. In Gujarat, The area, production and productivity during 2014-15 was 0.13 million ha, 0.036 million tones and 473 kg/ha, respectively (Anonymous, 2016b).

Seed being a biological or living entity, deterioration in its quality is inevitable, irreversible and inexorable. During storage, number of biotic and abiotic factors influenced the storage potential of seeds and resulted in gradual seed deterioration and ultimately death of the seeds (Kumar *et al.,* 2014). The extent of seed deterioration depends on species, seed containers, seed treatment, storage environment, duration of storage period and initial quality of stored seeds. The maintenance of seed quality during storage is the most important challenging in the crop due to problem of quick loss of seed quality. Seed treatments especially with bio-insecticides have been reported to be protectant against insect pests and the treated seeds were found to maintain higher germination owing to control of internal and external seed infestation (Phal *et al.*, 2003). The use of botanical pesticides is considered as one of the alternative substitute to hazardous chemicals. Among the botanicals, Neem is visualized as an eco-friendly pesticide having rich source of bioactive chemicals with a greater potential for use as successful pest control agent. Beneficial effects of neem seed kernel extracts and neem oil to improve germination percentage and seedling vigour is documented in some crops (Nakka *et al.*, 1998). Keeping this in view, the present study was conducted to evaluate the efficacy of neem formulations against quality parameters during long term storage of mungbean seeds.

MATERIALS AND METHODS

The present investigation was carried out at Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh

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from August, 2013 to June, 2015, wherein two kg of freshly harvested quality seed of mungbean cv. Gujarat Mungbean 4 (GM 4) having high germination percentage and low moisture content (below 8%) was taken for each repetition and treated as per following treatments viz., T_1 = Neem Seed Kernel Powder @ 5g/kg Seed, T_2= Neem Seed Kernel Powder @ 10g/kg Seed, T_3 = Neem Cake @ 5g/kg Seed, T_4 = Neem Cake @ 10g/kg Seed, T_5 = Neem dry leaf powder @ 5g / kg seed, T_6 = Neem dry leaf powder @ 10g / kg seed, T_7 = Neem Oil @ 2ml/kg seed, T_8= Neem Oil @ 5ml/kg seed, T_9 = Deltamethrin @ 40mg/kg Seed, and T_{10} = Control (Untreated). The experiment was carried out using Completely Randomized Design (CRD) repeated three times. After proper mixing or smearing, seeds were packed in 500 gauge polythene bags and kept in laboratory under ambient condition. Observations were recorded at bimonthly interval on germination (%), root length (cm), shoot length (cm), seedling dry weight (g), seed vigour index I, seed vigour index II and seed moisture content (%). The infestation/ damage in the seed (%) and number of insect/pest (live or dead) were also measured. Germination test was carried out using paper towel technique (ISTA, 1999). Germinated seeds were counted on 8thday and 10 germinated seedlings were selected from each replication of the treatment for calculating the seedling vigor index, which was calculated using the formula (Abdul-Baki and Anderson, 1973). The shoot and root length of each of the 10 seedlings were measured in centimeters. Seedling dry weightwas measured of all the germinated seedlings after oven drying. The data were statistically analyzed (Cochran and Cox, 1957).

RESULTS AND DISCUSSION

The results presented in Table 1 indicated that all treatments exhibited significant difference for germination percentage in mungbean over the periods. Among the treatments, significantly highest germination (96.00%) was recorded in the treatment T_4 (Neem Cake @ 10g/kg Seed) and it was at par with T_1 (Neem seed kernel powder @ 5 g/ kg seed) (94.67%), T_2 (Neem seed kernel powder @ 10 g/ kg seed) (91.33 %), T_7 (Neem Oil @ 2ml/kg seed) (88.00%) and T_3 (Neem Cake @ 5g/kg Seed) (87.67%) after 2 year of storage as compared to control (60.67%). The lowest germination (45.33%) was recorded in treatment T_8 (Neem Oil @ 5ml/kg seed). Vijayalakshmi and Goswami (1986) and Chormule *et al.* (2015) reported reduced germination in mungbean and chickpea due to neem oil treatment. Mandali and Reddy (2014) reported that all the neem formulations except neem oil were better in getting germination above seed certification standards after 6 month of storage in redgram.

The results presented in Table 2 indicated that treatments exhibited significant differences for root length in mungbean after 2 years of storage. Among the treatments, significantly highest root length (6.56 cm) was recorded in the treatment T_4 (Neem Cake @ 10g/kg Seed) and it was at par with T_3 (Neem Cake @ 5g/kg Seed) (6.51 cm), T_2 (Neem seed kernel powder @ 10 g/kg seed) (6.44 cm), T_5 (Neem dry leaf powder @ 5g/kg seed) (6.19 cm), T_8 (Neem Oil @ 5ml/kg seed) (5.96 cm) and T_6 (Neem dry leaf powder @ 10g/kg seed) (5.83 cm) after 2 year of storage. The lowest root length (4.99 cm) was recorded in T_7 (Neem Oil @ 2ml/ kg seed).Khatun *et al.* (2011) reported highest root length in lentil seeds treated with dry neem leaf powder.

The results presented in Table 3 indicated that treatments exhibited non-significant differences for shoot length (cm) under laboratory in mungbean after 2 year of storage. However, among all the treatments, highest shoot length (5.07 cm) was recorded in the treatment T_1 (Neem seed kernel powder @ 5 g/kg seed) and lowest shoot length (3.28 cm) was recorded in T_9 (Deltamethrin @ 40mg/kg seed). Khatun *et al.* (2011) reported highest shoot length in lentil seeds treated with dry neem leaf powder.

The results presented in Table 4 indicated that all the treatments exhibited significant differences for seedling

Table 1: Effects of seed treatments on germination (%) in mungbean [*Vigna radiata* (L.) Wilczek].

Treatmentd /Perio	2 Month	4 Month	6 Month	8 Month	10 Month	12 Month	14 Month	16 Month	18 Month	20 Month	22 Month	24 Month
T_1	98.67	98.67	96.33	97.67	99.00	97.67	96.00	92.67	93.67	98.33	73.33	94.67
T_2	98.67	97.33	97.33	98.00	98.67	99.00	90.67	86.67	94.67	98.67	73.33	91.33
T_3	98.00	98.33	97.00	96.00	98.00	98.67	98.33	85.00	93.67	99.00	89.67	87.67
T_4	97.33	96.67	97.33	97.33	98.33	90.00	84.00	96.67	98.67	96.67	82.67	96.00
T_5	99.00	98.67	98.00	98.33	97.33	98.00	97.67	96.33	65.67	61.67	57.00	56.00
T_6	97.67	99.00	98.67	90.00	90.33	90.67	89.33	88.67	66.33	68.00	63.33	66.00
T_7	96.00	90.67	98.33	84.00	77.00	68.33	66.67	59.67	97.33	97.67	86.00	88.00
T_8	92.67	86.67	85.00	96.67	71.33	67.00	61.67	58.33	63.67	68.00	37.67	45.33
T_9	93.67	94.67	93.67	98.67	98.00	98.00	92.00	78.00	59.33	66.67	49.33	60.67
T_{10}	98.33	98.67	99.00	96.67	80.00	73.67	67.67	63.00	50.00	59.00	45.33	66.00
Mean	97.00	95.93	96.07	95.33	90.80	88.10	84.40	80.50	78.30	81.37	65.77	75.17
S.Em. ±	0.88	0.97	1.62	0.93	0.71	0.85	1.39	1.82	1.84	0.75	1.86	3.55
C.D. at 5%	2.62	2.87	4.82	2.77	2.14	2.57	4.22	5.51	5.48	2.24	5.52	10.55
CV%	1.58	1.74	2.93	1.69	1.36	1.70	2.94	4.07	4.08	1.60	4.90	8.19

Table 2: Effects of seed treatments on root length (cm) in mungbean [*Vigna radiata* (L.) Wilczek].

Treatment /Period	2 Month	4 Month	6 Month	8 Month	10 Month	12 Month	14 Month	16 Month	18 Month	20 Month	22 Month	24 Month
T_1	12.03	11.33	10.47	10.73	7.51	9.82	10.08	11.33	7.87	6.03	7.08	5.09
T_2	12.47	9.89	10.90	10.02	7.71	10.46	11.28	11.77	7.19	8.03	5.89	6.44
T_3	11.83	11.27	10.01	11.03	8.37	10.25	10.87	11.33	7.22	8.33	6.28	6.51
T_4	11.70	10.29	10.13	10.67	8.92	10.34	11.07	11.03	7.87	8.23	6.30	6.56
T_5	12.13	10.59	10.40	10.50	7.71	9.77	10.20	10.80	7.87	8.47	6.36	6.19
T_6	11.10	11.05	9.96	10.80	8.75	9.61	11.27	11.57	7.98	8.00	6.71	5.83
T_7	10.47	11.20	10.40	10.90	8.63	9.92	10.93	11.07	7.83	8.30	4.56	4.99
T_8	10.77	10.79	10.53	10.60	8.83	9.96	10.73	11.00	7.93	7.53	6.59	5.96
T_9	12.20	10.28	9.45	10.33	8.52	9.59	11.13	10.90	7.95	7.73	6.90	5.47
T_{10}	11.89	10.84	10.64	10.83	8.37	10.02	11.15	11.13	8.07	8.38	3.07	5.94
Mean	11.66	10.75	10.29	10.64	8.33	9.97	10.87	11.19	7.78	7.90	5.97	5.90
S.Em. ±	0.18	0.27	0.23	0.25	0.46	0.24	0.28	0.19	0.081	0.12	0.43	0.33
C.D. at 5 %	0.54	0.80	0.67	N/A	N/A	N/A	N/A	0.56	0.24	0.35	1.29	0.98
CV%	2.69	4.35	3.79	4.11	9.56	4.14	4.47	2.91	1.80	2.62	12.57	9.68

Table 3: Effects of seed treatments on shoot length (cm) in mungbean [*Vigna radiata* (L.) Wilczek].

Treatment /Period	2 Month	4 Month	6 Month	8 Month	10 Month	12 Month	14 Month	16 Month	18 Month	20 Month	22 Month	24 Month
T_1	7.11	5.99	6.71	6.09	3.30	5.38	5.56	6.30	6.75	4.73	3.29	5.07
T_2	6.51	6.30	6.45	6.17	4.35	5.28	5.44	6.23	5.56	5.63	3.01	4.29
T_3	6.77	5.98	6.28	6.24	6.51	5.92	5.76	6.67	6.12	4.97	2.83	4.15
T_4	6.80	5.25	6.36	5.59	5.03	5.53	5.72	6.93	6.07	5.17	2.73	4.02
T_5	6.91	5.64	7.08	6.14	3.92	5.33	5.63	6.73	5.98	5.20	2.96	4.48
T_6	7.23	5.68	6.50	5.96	4.61	5.56	5.36	6.53	6.71	5.03	3.73	4.27
T_7	7.62	5.84	6.88	6.17	4.67	5.71	5.25	6.80	5.67	5.37	3.30	3.57
T_8	7.73	6.51	6.56	6.23	5.19	5.82	5.41	6.50	5.96	5.53	3.35	3.92
T_9	7.37	6.15	7.24	6.04	5.83	5.72	5.41	6.60	5.68	5.27	3.24	3.28
T_{10}	7.59	6.18	6.92	6.16	4.36	5.96	6.31	7.53	5.72	5.88	2.75	3.30
Mean	7.16	5.95	6.70	6.08	4.78	5.62	7.19	6.68	6.02	5.28	3.12	4.04
S.Em. ±	0.25	0.13	0.24	0.13	0.57	0.16	0.66	0.21	0.05	0.08	0.10	0.40
C.D. at 5	0.73	0.39	N/A	N/A	1.69	N/A	N/A	0.63	0.15	0.25	0.30	N/A
CV%	5.94	3.79	6.23	3.76	20.64	5.05	12.08	5.51	1.45	2.75	5.66	17.19

Table 4: Effects of seed treatments on seedling dry weight (g) in mungbean [*Vigna radiata* (L.) Wilczek].

Treatment /Period	2 Month	4 Month	6 Month	8 Month	10 Month	12 Month	14 Month	16 Month	18 Month	20 Month	22 Month	24 Month
T_1	3.01	4.21	3.44	3.51	3.41	3.83	3.69	3.22	3.37	3.13	3.37	4.01
T_2	3.20	3.50	3.24	3.07	3.90	3.70	3.72	3.64	3.70	3.22	3.08	3.81
T_3	2.86	3.07	3.61	3.32	3.76	3.79	3.93	3.60	3.32	3.64	3.97	3.46
T_4	3.63	3.39	3.72	3.19	3.82	3.81	3.34	3.15	3.44	2.95	3.73	3.69
T_5	2.90	3.69	3.46	3.60	3.55	3.89	3.59	3.14	3.47	2.99	3.47	4.09
T_6	3.44	3.57	3.57	3.47	3.67	3.71	3.61	3.36	3.12	2.73	4.47	4.25
T_7	3.16	3.47	3.54	3.41	3.26	3.53	3.29	3.10	3.14	3.03	3.52	3.79
T_8	2.86	3.10	3.16	3.03	2.82	2.56	2.97	2.63	1.89	2.03	3.21	2.80
T_9	2.87	3.41	3.31	3.62	3.43	3.51	3.94	3.09	3.27	2.87	3.42	4.25
T_{10}	2.99	3.69	3.99	3.55	3.64	3.72	3.79	3.37	3.21	2.99	3.47	4.39
Mean	3.09	3.51	3.51	3.38	3.53	3.61	3.59	3.23	3.19	2.96	3.57	3.85
S.Em. ±	0.12	0.14	0.09	0.08	0.06	0.07	0.09	0.11	0.11	0.15	0.16	0.13
C.D. at 5%	0.34	0.42	0.26	0.25	0.18	0.19	0.27	0.34	0.32	0.46	0.49	0.39
CV%	6.46	7.01	4.28	4.33	2.93	3.14	4.44	6.09	5.75	9.06	8.02	5.88

dry weight (g) in mungbean. Among the treatments, significantly highest seedling dry weight (4.39 g) was recorded in the treatment T_9 (Deltamethrin @ 40mg/kg seed) and it was at par with T_8 (Neem Oil @ 5ml/kg seed) (4.25 g), T_6 (Neem dry leaf powder @ 10g/kg seed) (4.25 g), T_5 (Neem dry leaf powder @ 5g/kg seed) (4.09 g), T_1 (Neem Seed kernel powder @ 5 g/kg seed) (4.01 g). The lowest seedling dry weight (2.80 g) was recorded in treatment T_8 (Neem Oil @ 5ml/kg seed). Khatun and Bhuiyan (2011) and Chormule *et al*. (2015) reported that highest value of seedlings dry weight was recorded by chickpea seed treated with dry neem leaf powder.

The results presented in Table 5 indicated that treatments exhibited significant differences for Seed Vigour Index I in mungbean after two years of storage. Among the treatments, significantly highest Seed Vigour Index I (1015.36) was recorded in the treatment T_4 (Neem Cake @ 10g/kg Seed) after 2 year of storage and it was at par with T_2 (Neem seed kernel powder @ 10 g/kg seed) (977.93), T_1 (Neem seed kernel powder @ 5 g/kg seed) (962.09) and T_3 (Neem Cake @ 5g/kg Seed) (939.95). The Seed Vigour Index I (440.59) was recorded in treatment T_8 (Neem Oil @ 5ml/kg seed). Khatun and Bhuiyan (2011) and Chormule *et al*. (2015) reported that highest value of seed vigour index was recorded by chickpea seed treated with dry neem leaf powder. Mandali and Reddy (2014) reported that seedling vigour index of redgram decreased with increase in storage period. All the neem formulations except neem oil were safer to the redgram seeds and maintained the germination of seeds above certification standards up to six months of storage.

The results presented in Table 6 indicated that treatments exhibited significant differences for Seed Vigour Index II in mungbean. Among the treatments, significantly highest Seed Vigour Index II (379.51) was recorded in the treatment T_1 (Neem seed kernel powder @ 5g/kg Seed) after 2 year of storage and it was at par with T_4 (Neem Cake @ 10g/kg Seed) (354.24), T_2 (Neem seed kernel powder @ 10 g/kg seed) (348.88) and T_7 (Neem Oil @ 5ml/kg seed) (333.87). The lowest Seed Vigour Index II (125.60) was recorded in treatment T_8 (Neem Oil @ 5ml/kg seed). Khatun

Table 5: Effects of seed treatments on Seed Vigour Index-I in mungbean [*Vigna radiata* (L.) Wilczek].

Treatment /Period	2 Month	4 Month	6 Month	8 Month	10 Month	12 Month	14 Month	16 Month	18 Month	20 Month	22 Month	24 Month
T_1	1889.00	1709.31	1654.59	1642.91	1020.21	1479.72	1516.13	1634.13	1369.25	1062.43	761.04	962.09
T_2	1872.48	1576.44	1688.01	1290.45	1137.85	1547.29	1600.69	1782.00	1206.24	1348.50	654.31	977.93
T_3	1823.16	1695.43	1579.40	1658.56	1374.09	1597.86	1629.09	1751.67	1249.57	1316.70	835.67	939.95
T_4	1799.94	1501.34	1605.42	1582.68	1287.95	1544.80	1645.09	1724.80	1375.41	1308.83	746.72	1015.36
T_5	1884.96	1602.29	1724.31	1635.99	1085.49	1479.80	1530.45	1718.27	909.81	842.60	531.62	604.05
T_6	1789.90	1654.62	1618.87	1624.20	1242.79	1497.25	1629.41	1755.60	974.21	886.27	661.01	667.99
T_7	1737.95	1545.15	1669.83	1537.66	1022.13	1068.89	1078.71	1065.90	1313.91	1334.77	675.67	752.83
T_8	1714.64	1499.28	1456.12	1413.33	1002.14	1057.13	995.47	1021.13	883.03	888.53	374.45	440.59
T_9	1833.21	1554.93	1563.12	1582.37	1344.67	1479.20	1621.57	1615.87	808.93	866.73	499.60	529.86
T_{10}	1915.86	1678.58	1738.44	1676.74	1020.33	1177.22	1181.96	1176.10	689.21	841.67	264.53	609.62
Mean	1826.11	1601.74	1629.81	1564.49	1153.77	1392.92	1442.86	1524.55	1077.96	1069.70	600.46	750.03
S.Em. $\pm$	38.86	32.45	46.56	95.58	79.59	30.31	34.38	25.00	25.52	14.48	42.07	51.28
C.D. at 5%	115.45	96.41	138.30	NS	236.44	90.05	102.12	74.27	75.80	43.03	124.97	152.34
CV%	3.69	3.51	4.95	10.58	11.95	3.77	4.13	2.84	4.10	2.34	12.13	11.84

Table 6: Effects of seed treatments on Seed Vigour Index-II in mungbean [*Vigna radiata* (L.) Wilczek].

Treatment /Period	2 Month	4 Month	6 Month	8 Month	10 Month	12 Month	14 Month	16 Month	18 Month	20 Month	22 Month	24 Month
T_1	297.00	415.80	331.11	342.46	321.36	372.38	358.57	298.43	315.99	308.02	248.96	379.51
T_2	315.46	341.00	315.40	301.28	367.88	363.93	355.88	360.36	350.41	318.03	226.96	348.88
T_3	280.53	301.63	350.56	318.72	347.66	375.54	385.47	350.40	310.79	360.69	356.59	304.92
T_4	353.65	327.77	362.50	307.85	352.45	370.48	327.32	302.72	339.42	285.08	309.01	354.24
T_5	287.43	364.42	341.42	353.68	331.66	381.55	347.29	307.39	227.67	184.42	197.79	228.87
T_6	336.37	353.76	351.03	341.26	341.65	367.62	351.08	325.85	207.00	185.87	282.89	280.25
T_7	303.97	314.94	342.55	306.53	250.80	241.47	220.21	184.87	305.64	295.95	302.17	333.87
T_8	264.99	268.67	269.44	255.51	200.95	171.64	183.35	153.31	120.75	137.81	121.03	125.60
T_9	268.41	322.74	310.37	349.64	320.79	339.27	386.12	254.11	194.36	191.09	169.62	257.63
T_{10}	293.95	364.44	395.34	349.97	290.95	274.01	256.22	211.83	159.97	176.47	157.07	289.96
Mean	300.18	337.52	336.97	322.69	312.62	325.79	317.15	274.93	253.20	244.34	237.20	290.37
S.Em. $\pm$	12.31	14.98	11.71	9.56	6.33	6.06	7.87	5.85	10.97	11.35	16.99	16.77
C.D. at 5%	36.56	44.50	34.78	28.40	18.81	18.00	23.38	17.39	32.60	33.72	50.46	49.81
CV%	7.10	7.69	6.02	5.13	3.51	3.22	4.30	3.69	7.51	8.05	12.40	10.00

Table 7: Effects of seed treatments on seed moisture (%)in mungbean [*Vigna radiata* (L.) Wilczek].

Treatment /Period	2 Month	4 Month	6 Month	8 Month	10 Month	12 Month	14 Month	16 Month	18 Month	20 Month	22 Month	24 Month
T_1	5.54	4.13	5.52	4.33	5.47	6.24	6.24	7.82	7.18	6.17	7.23	8.89
T_2	5.56	4.37	5.34	4.14	5.32	6.76	6.76	8.90	7.85	6.98	6.48	8.10
T_3	5.96	4.39	5.39	5.36	5.60	7.34	7.34	8.28	7.62	7.57	6.52	8.66
T_4	5.65	4.12	4.88	3.88	5.10	7.54	7.54	7.91	8.51	7.04	6.27	7.51
T_5	5.55	4.34	5.30	4.13	5.71	6.36	6.36	8.73	7.91	6.50	5.74	8.66
T_6	6.03	4.47	5.34	4.24	5.48	7.02	7.02	9.06	7.88	6.84	6.39	8.21
T_7	4.48	2.40	2.91	2.39	3.55	5.55	5.55	7.98	6.32	5.91	6.71	6.72
T_8	3.23	1.64	2.52	1.79	3.04	6.23	6.23	7.28	7.04	5.75	6.17	7.93
T_9	3.47	2.33	2.78	3.95	3.70	5.43	5.43	6.35	6.24	6.13	5.82	8.05
T_{10}	5.88	4.55	5.31	4.58	5.96	6.74	6.74	7.91	8.11	7.31	6.93	8.05
Mean	5.14	3.67	4.53	3.88	4.89	6.52	6.52	8.02	7.47	6.62	6.43	8.08
S.Em. ±	0.15	0.07	0.06	0.04	0.05	0.05	0.05	0.07	0.09	0.13	0.12	0.18
C.D. at 5%	0.44	0.21	0.17	0.11	0.15	0.16	0.16	0.20	0.26	0.38	0.35	0.53
CV%	4.97	3.32	2.17	1.68	1.77	1.44	1.44	1.42	2.04	3.39	3.21	3.84

and Bhuiyan (2011) and Chormule *et al*. (2015) reported that highest seed vigour index was recorded by chickpea seed treated with dry neem leaf powder.

The results presented in Table7 indicated that treatments exhibited significant differences for seed moisture in mungbean. Among the treatments, significantly highest seed moisture content (8.89 %) was recorded in the treatment T_1 (Neem seed kernel powder @ 5g/kg Seed) after 2 year of storage storage and it was at par with T_3 (Neem Cake @ 5 g/ kg Seed) (8.66 %) and T_5 (Neem dry leaf powder @ 5 g/kg seed) (8.66 %). The lowest seed moisture (6.72 %) was recorded in treatment T_7 (Neem Oil @ 2 ml/kg seed). Present findings are in conformity with Chormule *et al*. (2015) in chickpea. Oyekale *et al*. (2012) stored the seed of sesame at ambient conditions in Nigeria, in moisture pervious and moisture proof container with or without seed treatments and concluded that with increasing length of storage, the seed moisture content increased and viability decreased.

There is no infestation/damage in the seed due to insect attack in stored sample after two years of storage. Abdul-Rafiu (2006) found that there is no any infestation of storage pest in neem based treatments. Mandali and Reddy (2014) reported that neem formulations were safer seed protectants for long term storage of redgram against *Callosobruchus chinensis.*

As the storage period advanced, there was a decrease in seed quality parameters gradually (Raikar *et al.*, 2011). This indicated that natural ageing is inevitable in all the species as well as seeds. After physiological maturity, seeds begin to deteriorate at varying rate depending upon the conditions of storage environment (Copeland, 1988), who have highlighted the deteriorative changes in seed which include membrane degradation, accumulation of toxic metabolites, decreased enzymatic activity, lipid auto-oxidation, failure of repair mechanisms and genetic degradation. Consequences of these factors led to reduced viability / germinability and vigour in stored seeds.

In the present investigation, the treated seed was stored in 500 gauge polythene bags. Bhattacharya and Basu (1990) reported that retention of vigour and viability of stored pea in plastic container. Phal *et al.* (2003) reported that seeds of mungbean stored in HDPE bags under ambient condition retained higher vigour as compared to the seeds in paper packet.

CONCLUSION

From the results and discussion, it can be concluded and recommended that mungbean seed may be storedin normal condition packed in HDPE bags (500 gauge) with seed treatment (Neem seed kernel powder @ 5 to 10 g/kg seed or Neem Cake @ 5-10 g/kg seed) for a period of 2 years without deterioration in germination and seedling vigour.

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