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Bio-efficacy of different botanicals against aphid, *Aphis craccivora* Koch infesting cowpea *Vigna unguiculata* (L.) Walp.

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Abstract
An experiment was conducted under field condition at Anand Agricultural University, Anand during summer and *kharif* 2017. To evaluate bio-efficacy of different botanicals against aphid, *Aphis craccivora* in cowpea, seven botanical insecticides *viz*; Neem Seed Kernel Extract (NSKE) 5%, Neem Oil 0.3%, Neem Leaf Extract (NLE) 10%, Garlic Bulb Extract (GBE) 3%, *Lantana camera* Leaf Extract 10%, Tobacco Decoction 2% and Ginger Rhizome Extract (GRE) 5% were evaluated for their relative bio-efficacy against aphid infesting cowpea. Neem oil, GBE and NSKE found more effective against aphid on cowpea. The NLE, tobacco decoction and GRE proved moderate in their effectiveness. In contrast to this, *L. camera* leaf extract emerged as a poor treatment to manage aphids in cowpea during both the seasons. Maximum seed yield was recorded in plots treated with neem oil followed by GBE and NSKE. These three botanicals found significantly more effective which reflected on yield of cowpea. The highest NICBR obtained in treatment NSKE followed by GBE and neem oil during summer and *kharif*, 2017.

Keywords: Bio-efficacy, Botanicals, Aphid, Cowpea

Introduction
Pulses have been standard as major sources of protein in human as well as restorer of soil fertility by fixing the atmospheric nitrogen in soil. It constitutes the cheapest source of dietary protein and energy for poor people, so it is known as "vegetable meat" and "poor man's meat" (Davis *et al*., 1991) [3]. In India, total area under pulses is 25.26 million hectares with the total production of 16.47 million tonnes and productivity of 652 kg per hectare. In Gujarat, area under cowpea is 0.52 million hectares and the production 0.35 million tonne with the productivity of 665 kg per hectare (Anon., 2015) [1]. In India, cowpea is mainly grown in the states of Karnataka, Kerala, Maharashtra and Tamil Nadu for seed, green pods, animal fodder and organic green manure use. In Gujarat, cowpea is mainly grown in the districts of Kutch, Banaskantha, Mehsana and Panchmahal in *kharif* season under inadequate and erratic rainfall. The crop is ravaged by many insect pests at different stages of its growth. As many as 21 insect pests of different groups have been observed damaging the crop right from germination to maturity of the crop (Prajapati *et al.*, 2009) [10]. Among them, aphid is the major pest of cowpea causing economic losses directly by sucking the cell sap from leaves, twigs, pods and produce black sooty mould. Whereas, indirectly through transmission of viral diseases. *Aphis craccivora* causes significant yield loss of about 20-40 per cent in Asia (Ghareeb *et al*., 2002) [5]. Obopile (2006) [7] reported that allowing aphids to feed on cowpea plants beyond three weeks resulted in more than 50 per cent yield losses.

Materials and Methods
Field experiment was conducted at Anand Agricultural University, Anand during summer and *kharif*, 2017 in Randomized Block Design with eight treatments and three replications with a view to evaluate bio-efficacy of different botanicals against *A. craccivora* on cowpea. Cowpea cultivar Pusa Phalguni was sown, with a spacing of 60 cm between two rows and 30 cm within the rows in gross and net area of 4.50 x 3.60 m^2 and 3.90 x 2.40 m^2, respectively. Insecticidal sprays were applied as and when incidence of aphid on cowpea crop was noticed. Subsequent two sprays were given at 10 days interval. The spray was given by using knapsack sprayer

with hollow cone nozzle. For the purpose of recording the observations, five plants were randomly selected from net plot area and tagged. Observations on number of aphids present on 3 cm terminal part of central shoot of each tagged plant were recorded prior as well as 1, 3, 7, 10 and 15 days after each spray. The data obtained were analyzed by following standard statistical technique (Steel and Torrie, 1980) [14].

Results and Discussion

The population of aphids was homogeneous in all the treatments before spray and difference was non-significant during both the seasons. All the evaluated botanicals were significantly superior to control up to 10 days of spray.

Summer, 2017

First spray: Aphid population recorded at three days after spray (DAS) clearly indicated that it was significantly decreased in all the treated plots over untreated check (Table 1) up to ten days as well as in pooled over periods. Among the various botanical insecticides, Neem oil exhibited minimum (12.97/twig) number of aphids but it was at par with GBE (13.19/twig), NSKE (13.94/twig) and NLE (19.57/twig). Among the botanical pesticides, the highest (22.44/twig) population of aphid was recorded in plots treated with *L. camera* leaf extract and it was at par with tobacco decoction (21.22/twig), GRE (21.87/twig) and untreated (28.02/twig) plots.

After five days of the first spray, the lowest population of aphid was noticed in plots receiving neem oil (8.56/twig) and it was at par with GBE (9.05/twig) and NSKE (9.23/twig). These three treatments were found significantly superior to rest of the botanical materials. Of the evaluated botanicals, the highest (21.31/twig) number of aphids were observed in plots treated with *L. camera* leaf extract which was found at par with NLE (14.71/twig), tobacco decoction (15.02/ twig) and GRE (15.58/twig). More or less similar trend of efficacy was observed after seven days of spray as recorded after five days of spray.

After ten days of spray, neem oil (9.93/twig), NSKE (10.32/twig) and GBE (10.39/twig) were found equally effective and significantly superior to rest of the botanicals. Among the tested botanicals, significantly the highest (18.77/twig) number of aphids was found in plots treated with *L. camera* leaf extract followed by GRE (16.23/twig), tobacco decoction (15.82/twig) and NLE (15.50/twig) remained at par with each other.

The data on pooled over periods result exposed that the highest efficacy was found with the application of neem oil (9.23/twig) and it was at par with, GBE (9.68/twig) and NSKE (9.93/twig). These treatments remained significantly more effective than rest of the tested botanicals. Of the tested botanicals, the highest (19.66/twig) population of aphids was recorded in plots treated with *L. camera* leaf extract and found at par with NLE (15.18/twig), tobacco decoction (15.74/twig) and GRE (16.23/twig).

Second Spray: Effectiveness of different botanical pesticides against aphid population recorded at three days after the second spray clearly indicated that there was significant decrease in the aphid incidence in all the treated plots over untreated check (Table 1). Among the various botanical pesticides, neem oil proved to be the most effective as it recorded the lowest (7.97/twig) population of aphids. However, it was at par with NSKE (8.44/twig) and GBE (8.50/twig). The lowest efficacy was found in plots treated with *L. camera* leaf extract by recording highest (17.73/twig) population of aphids and it was at par with NLE (13.79/twig), tobacco decoction (13.94/twig) and GRE (14.71/twig).

The data of five days after the second spray showed that all the evaluated botanicals were significantly superior to untreated control. Among the tested different botanical pesticides, minimum (6.79/twig) number of aphids was recorded in plots treated with neem oil and it was at par with NSKE (6.44/twig) and GBE (7.28/twig). These three treatments of botanicals were found significantly superior to rest of the treatments. Of the evaluated botanicals the lowest efficacy was found in plot treated with *L. camera* leaf extract as it recorded the highest (17.79/twig) population of aphid and it was at par with NLE (12.46/twig), tobacco decoction (12.60/twig), GRE (12.97/twig) and control (24.10/twig). More or less the trend of efficacy after seven days of spray remained similar as observed after five days.

After ten days of the second spray, aphid population increased in all the botanical pesticides treated plots. Among the various botanical pesticides, neem oil recorded significantly the lowest (7.23/twig) number of aphids but was found at par with NSKE (7.62/twig) and GBE (7.62/twig). The treatments NLE (12.90/twig), tobacco decoction (13.04/twig), GRE (13.49/twig) and *L. camera* leaf extract (18.95/twig) were found least effective.

Pooled data computed for second spray indicated that the neem oil proved superior in suppressing the aphid incidence as this treatment registered significantly lowest (6.68/twig) population of aphids but it was at par with NSKE (7.01/twig) and GBE (7.17/twig). The botanical pesticides NLE (12.39/twig), tobacco decoction (12.46/twig) and GRE (13.04/twig) registered relatively less population of aphid and it were at par with each other. Among the evaluated botanical pesticides, maximum population was noticed in *L. camera* leaf extract (17.99/twig) and it was at par with control (22.73/twig).

Pooled over sprays

Overall pooled data (Table 1 and depicted in Fig. 1) computed for both the sprays indicated that significantly less number (7.91/twig) of aphids was recorded in plots treated with neem oil suggesting its superiority over rest of the treatments. GBE (8.38/twig) and NSKE (8.44/twig) were also found next better treatments to neem oil in reducing the aphid incidence. Treatments of NLE (13.79/twig), tobacco decoction (14.09/twig) and GRE (14.63/twig) were found less effective. Among botanical pesticides *L. camera* leaf extract recorded significantly maximum (18.86/twig) aphid population and proved inferior in controlling the pest.

***Kharif*, 2017**

First Spray: Aphid population recorded at three days after first spray indicated (Table 2) that significantly the lowest (11.82/twig) population of aphids was observed in the treatment of neem oil but it was at par with GBE (12.68/twig) and NSKE (12.97/twig). The treatments of NLE (18.51/twig), tobacco decoction (18.60/twig) and GRE (18.68/twig) were at par with each other and found equally effective in checking aphid population on cowpea. Among the evaluated botanical insecticides, the highest (26.02/twig) aphid population was recorded in *L. camera* leaf extract and it was at par with untreated plots (31.20/twig). The population of aphids was significantly reduced in all the botanical pesticides treated plots over untreated control till ten days of spray as well as in

pooled analysis. More or less the trend of efficacy after five days of spray was similar as observed after three days.

The lowest aphid population (5.36/twig) was noticed in the plot treated with neem oil and it was at par with GBE (6.26/twig) and NSKE (6.84/twig) after seven days of spray. NLE (10.79/twig), tobacco decoction (12.10/twig) and GRE (12.32/twig) were at par with each other and found least effective against aphids in cowpea. The highest (15.98/twig) aphid population was recorded in *L. camera* leaf extract and it was at par with GRE (12.32/twig).

Likewise, in ten days after the first spray, slight increase in the population of aphid in all the botanical pesticides treated plots was observed. Among the various botanical pesticides, neem oil (10.59/twig), GBE (10.99/twig) and NSKE (11.26/twig) were most effective and at par with each other. The treatments NLE (18.08/twig), tobacco decoction (17.99/twig), GRE (18.08/twig) and *L. camera* leaf extract (20.94/twig) were least effective.

Pooled over periods data (Table 2) of first spray revealed that neem oil (8.68/twig), GBE (9.30/twig) and NSKE (9.80/twig) were found significantly superior over rest of the evaluated botanicals. The treatments NLE (15.42/twig), tobacco decoction (16.06/twig), GRE (16.23/twig) and *L. camera* leaf extract (21.22/twig) were found equally effective and remained as next better group of botanicals in reducing aphid population in cowpea.

Second Spray

Aphid population recorded after three days of second spray indicated (Table 2) that significantly the lowest (8.80/twig) population of aphid was observed in the treatment of neem oil but it was found at par with GBE (9.42/twig) and NSKE (9.49/twig). The treatments of NLE (15.98/twig), tobacco decoction (15.90/twig) GRE (16.56/twig) and *L. camera* leaf extract (20.11/twig) were found at par with each other but remained significantly superior over control. Analogous results were observed at five days after second spray.

At seven days after spray, significantly the lowest (5.80/twig) population of aphids was observed in the treatment of neem oil but it remained at par with GBE (5.90/twig) and NSKE (6.47/twig). NLE (11.96/twig), tobacco decoction (12.17/twig) and GRE (12.97/twig) recorded less incidence of aphid then control but were found at par with each other. Among the evaluated botanical insecticides, the highest (17.06/twig) aphid population was recorded in *L. camera* leaf extract.

At ten days after second spray, neem oil (7.85/twig) was found significantly most effective followed by GBE (8.03/twig) and NSKE (8.26/twig). The treatments NLE (13.34/twig), tobacco decoction (14.55/twig), GRE (15.02/twig) and *L. camera* leaf extract (19.04/twig) were found superior over control.

Looking to the data on pooled over periods, significantly the lowest (7.62/twig) population of aphids was recorded in plots treated with neem oil but it was at par with GBE (7.97/twig) and NSKE (8.20/twig). The plots treated with *L. camera* leaf extract recorded the highest (18.60/twig) aphid population but it remained at par with NLE (14.25/twig), tobacco decoction (14.55/twig) and GRE (15.10/twig).

Pooled Over Sprays

The data (Table 2 and depicted in Fig. 1) of pooled over sprays revealed that the lowest (8.14/twig) population of aphids was noticed in the plots treated with neem oil. However, it was at par with GBE (8.62/twig) and NSKE (8.99/twig). Plots treated with NLE (14.87/twig), tobacco decoction (15.26/twig) and GRE (15.66/twig) were at par with each other but were found significantly superior over *L. camera* leaf extract and control. Among the evaluated botanical pesticides, the maximum (19.93/twig) aphid population was recorded in *L. camera* leaf extract.

Dalwadi *et al*. (2008) [2] mentioned that, significantly least (12.32/twig) incidence of *A. craccivora* was recorded in plots treated with NSKE @ 5% in Indian bean followed by NLE 10% (14.36/twig). According to Sharma *et al*. (2012) [6], minimum *A. craccivora* infestation was observed on fenugreek with three foliar application of neem oil (1%) which was significantly superior over karanj oil (1%), garlic bulb extract (5%) and NLE (5%). Neem oil (1%) and NSKE (5%) emerged out as effective botanical pesticides against suking pests (aphid, thrips and jassid) infesting cowpea (Khade *et al*., 2014) [13]. These findings are in corroboration with the present work.

Seed yield

Summer, 2017

The data on cowpea seed yield were recorded from various botanical treatments as well as from control at harvest and are presented in Table 3 and depicted in Fig. 2. Maximum (670 kg/ha) seed yield was recorded in plots treated with neem oil but it was at par with GBE (665 kg/ha) and NSKE (663 kg/ha). These three botanicals were found significantly more effective which also reflected on yield of cowpea. Among the tested botanicals, the lowest (487 kg/ha) yield of cowpea was recorded in plots treated with *L. camera* leaf extract but it was at par with NLE (557 kg/ha), tobacco decoction (551 kg/ha), GRE (550 kg/ha) and control plot (434 kg/ha).

Kharif, 2017 Data (Table 3 and depicted in Fig. 2) on seed yield of cowpea recorded in different plots treated with botanical pesticides showed higher seed yield in all the treated plots over untreated check during *kharif*, 2017. The significantly highest (632 kg/ha) seed yield was obtained in plots sprayed with neem oil but it was at par with GBE (627 kg/ha) and NSKE (624 kg/ha). Among the evaluated botanicals, minimum seed yield (478 kg/ha) was recorded in *L. camera* leaf extract followed by GRE (527 kg/ha), tobacco decoction (531 kg/ha) and NLE (533 kg/ha). *L. camera* leaf extract was not different to untreated control (436 kg/ha) in yield performance.

Increase in yield over control (Table 3) in cowpea crop was worked out for different botanical treatments and indicated that maximum (54.37%) increase in yield was found in plots treated with neem oil followed by GBE (53.22%) and NSKE (52.76%). Among the tested botanicals, minimum (12.21%) increase in yield was found in plots treated with *L. camera* leaf extract followed by GRE (26.72%), tobacco decoction (26.95%) and NLE (28.34%) during summer, 2017. Analogous results were recorded during *kharif*, 2017.

According to Saxena and Kidiavai (1997) [12], cowpea grain yield was significantly higher in plots sprayed with 20% neem seed extract than untreated control. Oparaeke (2007)[8] registered significantly higher grain yield of cowpea at 10 and 20% neem seed extract as compared to 5% extract. Effectiveness of neem seed kernel extract in controlling the insect pests and increase in grain yields of cowpea has been reported by Egho and Emosairue (2010) [4]. All these reports are in conformity with the present findings.

Table 1: Bio-efficacy of botanical pesticides against *A. craccivora* on cowpea during summer, 2017

Sr. No.	Treatment	Conc. (%)	No. of aphids/ twig days after spray											
			Before spray	First Spray					Second Spray					Pooled over spray
				3	5	7	10	Pooled	3	5	7	10	Pooled	
T_1	Neem seed kernel extract (NSKE)	5.0	5.13a (25.82)	3.80a (13.94)	3.12a (9.23)	2.70a (6.79)	3.29a (10.32)	3.23a (9.93)	2.99a (8.44)	2.73a (6.95)	2.36a (5.07)	2.85a (7.62)	2.74a (7.01)	2.99a (8.44)
T_2	Neem oil	0.3	5.03a (24.80)	3.67a (12.97)	3.01a (8.56)	2.58a (6.16)	3.23a (9.93)	3.12a (9.23)	2.91a (7.97)	2.70a (6.79)	2.31a (4.84)	2.78a (7.23)	2.68a (6.68)	2.90a (7.91)
T_3	Neem leaf extract (NLE)	10.0	4.88a (23.31)	4.48ab (19.57)	3.90b (14.71)	3.44b (11.33)	4.00b (15.50)	3.96b (15.18)	3.78b (13.79)	3.60b (12.46)	3.32b (10.52)	3.66b (12.90)	3.59b (12.39)	3.78b (13.79)
T_4	Garlic bulb extract (GBE)	3.0	4.97a (24.20)	3.70a (13.19)	3.09a (9.05)	2.67a (6.63)	3.30a (10.39)	3.19a (9.68)	3.00a (8.50)	2.79a (7.28)	2.38a (5.16)	2.85a (7.62)	2.77a (7.17)	2.98a (8.38)
T_5	*Lantana camera* leaf extract	10.0	5.18a (26.33)	4.79c (22.44)	4.67bc (21.31)	4.09c (16.23)	4.39b (18.77)	4.49b (19.66)	4.27b (17.73)	4.30bc (17.79)	4.21cd (17.22)	4.41c (18.95)	4.30bc (17.99)	4.40c (18.86)
T_6	Tobacco decoction (cold water method)	2.0	5.29a (27.48)	4.66bc (21.22)	3.94b (15.02)	3.46c (11.47)	4.04b (15.82)	4.03b (15.74)	3.80b (13.94)	3.62b (12.60)	3.34b (10.66)	3.68bc (13.04)	3.60b (12.46)	3.82b (14.09)
T_7	Ginger rhizome extract (GRE)	5.0	4.98a (24.30)	4.73bc (21.87)	4.0b (15.58)	3.51c (11.83)	4.09b (16.23)	4.09b (16.23)	3.90b (14.71)	3.67b (12.97)	3.40bc (11.06)	3.74bc (13.49)	3.68b (13.04)	3.89b (14.63)
T_8	Control. . . . . (water spray)	-	5.03a (24.80)	5.34c (28.02)	5.12c (25.71)	5.15d (26.02)	5.07c (25.20)	5.17c (26.23)	4.92c (23.71)	4.96c (24.10)	4.76d (22.16)	4.63d (20.94)	4.82c (22.73)	5.00d (24.50)
S. Em. ±. . . . . Treatment (T)			0.31	0.28	0.25	0.24	0.23	0.20	0.24	0.25	0.25	0.22	0.21	0.18
Period (P)			-	-	-	-	-	0.08	-	-	-	-	0.06	0.05
Spray (S)			-	-	-	-	-	-	-	-	-	-	-	0.03
T x P			-	-	-	-	-	0.19	-	-	-	-	0.13	0.14
T x S			-	-	-	-	-	-	-	-	-	-	-	0.07
P x S			-	-	-	-	-	-	-	-	-	-	-	0.06
T x P x S			-	-	-	-	-	-	-	-	-	-	-	0.18
C.V. %			10.75	11.08	11.33	12.09	10.08	18.00	11.05	12.01	13.23	10.53	20.32	19.38

Note: Figures in parentheses are retransformed values of $\sqrt{x + 0.5}$
Treatment means with the letter(s) in common are not significant by DNMRT at 5 % level of significance

Table 2: Bio-efficacy of botanical pesticides against *A. craccivora* on cowpea during *kharif*, 2017

Sr. No.	Treatment	Conc. (%)	No. of aphids/ twig days after spray											
			Before spray	First Spray					Second Spray					Pooled over spray
				3	5	7	10	Pooled	3	5	7	10	Pooled	
T_1	Neem seed kernel extract (NSKE)	5.0	5.45a (29.20)	3.67a (12.97)	3.06a (8.86)	2.71a (6.84)	3.43a (11.26)	3.21a (9.80)	3.16a (9.49)	3.07a (8.92)	2.64a (6.47)	2.96a (8.26)	2.95a (8.20)	3.08a (8.99)
T_2	Neem oil	0.3	5.68a (31.76)	3.51a (11.82)	2.88a (7.79)	2.42a (5.36)	3.33a (10.59)	3.03a (8.68)	3.05a (8.80)	2.95a (8.20)	2.51a (5.80)	2.89a (7.85)	2.85a (7.62)	2.94a (8.14)
T_3	Neem leaf extract (NLE)	10.0	5.22a (26.75)	4.36b (18.51)	3.95b (15.10)	3.36b (10.79)	4.31bc (18.08)	3.99b (15.42)	4.06b (15.98)	4.05b (15.90)	3.53b (11.96)	3.72b (13.34)	3.84b (14.25)	3.92b (14.87)
T_4	Garlic bulb extract (GBE)	3.0	5.94a (34.78)	3.63a (12.68)	2.91a (7.97)	2.60a (6.26)	3.39a (10.99)	3.13a (9.30)	3.15a (9.42)	3.04a (8.74)	2.53a (5.90)	2.92a (8.03)	2.91a (7.97)	3.02a (8.62)

T_5	*Lantana camera* leaf extract	10.0	5.69a (31.88)	5.15cd (26.02)	4.80cd (22.54)	4.06c (15.98)	4.63c (20.94)	4.66c (21.22)	4.54bc (20.11)	4.33c (18.25)	4.19b (17.06)	4.42bc (19.04)	4.37b (18.60)	4.52b (19.93)
T_6	Tobacco decoction (cold water method)	2.0	5.39a (28.55)	4.37b (18.60)	4.04b (15.82)	3.55b (12.10)	4.30bc (17.99)	4.07b (16.06)	4.05b (15.90)	4.03b (15.74)	3.56b (12.17)	3.88b (14.55)	3.88b (14.55)	3.97b (15.26)
T_7	Ginger rhizome extract (GRE)	5.0	5.25a (27.06)	4.38b (18.68)	4.09bc (16.23)	3.58bc (12.32)	4.31bc (18.08)	4.09b (16.23)	4.13b (16.56)	4.04b (15.82)	3.67b (12.97)	3.94b (15.02)	3.95b (15.10)	4.02b (15.66)
T_8	Control. . . . .. (water spray)	-	5.50a (29.75)	5.63d (31.20)	5.60d (30.86)	5.39d (28.55)	5.69d (31.88)	5.58d (30.64)	5.72c (32.22)	5.44d (29.09)	5.23c (26.85)	4.97c (24.20)	5.34c (28.02)	5.46c (29.31)
S. Em. ±. . . . . .. Treatment (T)			0.37	0.23	0.25	0.21	0.29	0.15	0.26	0.31	0.21	0.23	0.24	0.18
Period (P)			-	-	-	-	-	0.08	-	-	-	-	0.04	0.04
Spray (S)			-	-	-	-	-	-	-	-	-	-	-	0.03
T x P			-	-	-	-	-	0.23	-	-	-	-	0.11	0.12
T x S			-	-	-	-	-	-	-	-	-	-	-	0.10
P x S			-	-	-	-	-	-	-	-	-	-	-	0.07
T x P x S			-	-	-	-	-	-	-	-	-	-	-	0.19
C.V. %. . ..			11.67	9.27	11.22	10.30	12.07	12.98	11.16	13.80	10.66	10.50	21.74	22.99

Note: Figures in parentheses are retransformed values of $\sqrt{x + 0.5}$
Treatment means with the letter(s) in common are not significant by DNMRT at 5 % level of significance

Table 3: Effect of botanical pesticides on yield of cowpea applied for control of *A. craccivora*

Sr. No.	Treatments	Summer			*Kharif*		
		Seed yield (kg/ha)	Increase in yield over control (%)	NICBR	Seed yield (kg/ha)	Increase in yield over control (%)	NICBR
T_1	Neem seed kernel extract (NSKE)	663a	52.76	1:5.15	624a	43.11	1:4.05
T_2	Neem oil	670a	54.37	1:4.89	632a	44.95	1:3.89
T_3	Neem leaf extract (NLE)	557b	28.34	1:3.29	533b	22.24	1:2.38
T_4	Garlic bulb extract (GBE)	665a	53.22	1:5.09	627a	43.80	1:4.04
T_5	*Lantana camera* leaf extract	487bc	12.21	1:0.81	478bc	09.00	1:0.43
T_6	Tobacco decoction (cold water method)	551b	26.95	1:3.88	531b	21.78	1:2.94
T_7	Ginger rhizome extract (GRE)	550b	26.72	1:0.33	527b	20.87	1:0.08
T_8	Control (water spray)	434c	-	-	436c	-	-
S. Em. ±		33.17	-	-	29.12	-	
C.V. %		10.03	-	-	9.19	-	

Note: Treatment means with the letter(s) in common are not significant by DNMRT at 5 % level of significance

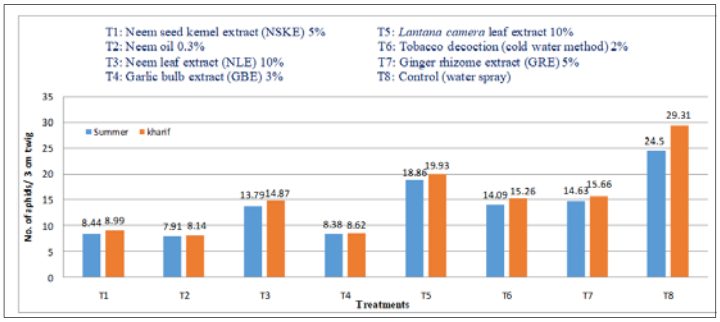

Fig 1: Bio-efficacy of botanicals against *A. craccivora* infesting cowpea (Pooled over sprays)

T1: Neem seed kernel extract (NSKE) 5%. . . . . T5: Lantana camera leaf extract 10%
T2: Neem oil 0.3%. . . . . .. T6: Tobacco decoction (cold water method) 2%
T3: Neem leaf extract (NLE) 10%. . . . . .. T7: Ginger rhizome extract (GRE) 5%
T4: Garlic bulb extract (GBE) 3%. . . . . .. T8: Control (water spray)

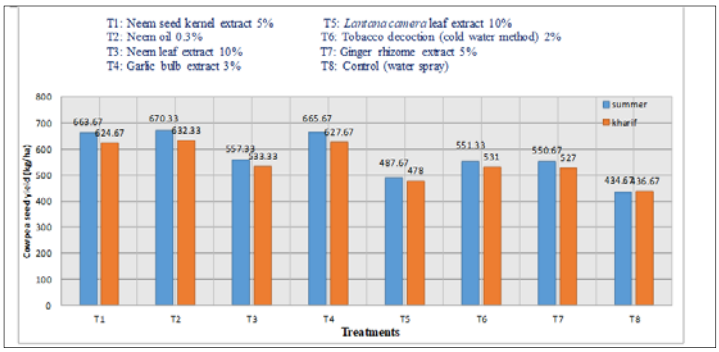

Fig 2: Effect of different botanical treatments on cowpea seed yield

T1: Neem seed kernel extract 5%. . . . . T5: Lantana camera leaf extract 10%
T2: Neem oil 0.3%. . . . . T6: Tobacco decoction (cold water method) 2%
T3: Neem leaf extract 10%. . . . . .. T7: Ginger rhizome extract 5%
T4: Garlic bulb extract 3%. . . . . T8: Control (water spray)

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The highest (1: 5.15) NICBR obtained in treatment NSKE followed by GBE (1: 5.09) and neem oil (1: 4.89). The NICBR 1: 3.88 and 1: 3.29 were found in treatments of tobacco decoction and NLE, respectively. The NICBR (1: 0.33) was poor in the treatment of GRE and *L. camera* leaf extract (1: 0.81).

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Looking to the NICBR, the highest (1: 4.05) return was received with the treatment of NSKE followed by GBE (1: 4.04) and neem oil (1: 3.89). The NICBR was 1: 2.94 and 1: 2.38 calculated for the treatments of tobacco decoction and NLE, respectively. The NICBR (1: 0.08) was comparatively less with the treatment of GRE and *L. camera* leaf extract (1: 0.43).

Sarvaiya (2017)[11] registered the maximum net realization in the treatment of azadirachtin 0.15 EC and maximum ICBR was registered in neem oil 0.3%. Patel (2014)[9] revealed that the maximum ICBR was found in the treatment of neem oil (1: 47.94) followed by NSKE (1: 41.28), which are in conformity with the present reports.

In conclusion, among the seven different botanicals evaluated, Neem oil, GBE and NSKE found more effective against aphid on cowpea. Maximum seed yield was recorded in plots treated with neem oil followed by GBE and NSKE. These three botanicals found significantly more effective which reflected on yield of cowpea. The highest NICBR obtained in treatment NSKE followed by GBE and neem oil during summer and *kharif*, 2017.

References

1. Anonymous. Agricultural statistics at a glance, Govt. of India, Department of Agricultural cooperation and farmers welfare, 2015, 104.
2. Dalwadi MM, Korat DM, Tank BD. Bio-efficacy of Some Botanical Insecticides Against Major Insect Pests of Indian Bean, *Lablab purpureus* L. Karnataka J. of Agricultural Sciences. 2008; 21(2):295-296.
3. Davis DW, Oelke EA, Doll JD, Hanson CV, Putnam DH. Alternative Field Crop Manual, 1991.
4. Egho EO, Emosairue SO. Effect of neem seed kernel extract on major insect pests of cowpea and influence on yield under calendar and monitored sprays. Annals Biological Research. 2010; 1(2):210-220.
5. Ghareeb M, Nasser MK, Sayed AK, Mohamed GA. Possible mechanisms of insecticides resistance in cowpea aphid, *A. craccivora* Koch The role of general esterase and oxidase enzymes in insecticides resistances of cowpea. The first conformance Central Insecticides Laboratory. 2002; 3-5(2):635-649.
6. Khade KN, Kalinkar AS, Gurve SS, Shinde SR. Biorational management of sucking pests of cowpea (*Vigna sinensis* L.). Trends in Bioscience. 2014; 7(17):2570-2573.

7. Obopile M. Economic threshold and injury levels for control of cowpea aphids. African Plant Protection. 2006; 12:111-115.
8. Oparaeke AM. Synergistic activity of aqueous extracts mixtures of some Nigerian plants against *Maruca vitrata* and *Clavigralla tomentosicollis* on field cowpea. Archives Phytopathology and Plant Protection. 2007; 40(4):257-263.
9. Patel SR. Seasonal abundance and eco-friendly management of aphid, *Aphis gossypii* Glover infesting isabgol, *Plantago ovate*, Forskel. M. Sc. Thesis submitted to Anand Agricultural University, Anand (Gujarat), 2014.
10. Prajapati BG, Dodia DA, Tikka SBS, Acharya S. Field evaluation of certain newer molecules of insecticides against spotted pod borer, *Maruca vitrata* infesting cowpea. Journal of Arid Legs. 2009; 6(2):119-121.
11. Sarvaiya RM. Biology and management of aphid, *Aphis craccivora* Koch infesting fenugreek, *Trigonella foenum-graecum* (Linnaeus) M. Sc. Thesis submitted to Anand Agricultural University, Anand (Gujarat), 2017.
12. Saxena RC, Kidiavai EL. Neem seed extract spray applications as low-cost inputs for management of flower thrips in cowpea crop. Phytoparasitica. 1997; 25(2):99-110.
13. Sharma SK, Trivedy A, Ameta OP, Sharma S, Choudhary R, Hussain T. Evaluation of botanicals extract against aphid management in fenugreek under organic farming. Indian Journal of Applied Entomology. 2012; 26(2):88-92.
14. Steel RGD, Torrie JH. Principles and procedures of statistics. Publ. McGraw Hill Book Company, New York, 1980, 137.