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Effect of Different farming systems on management of insect pests and population of Natural Enemies in Groundnut and Blackgram

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ABSTRACT

Field studies were carried out at Seed Farm, ZAHRS Brahmavar, Udupi, Karnataka during *summer* 2019 on effect of different farming systems on insect pests and natural enemies in groundnut and blackgram. Three days after first spray in groundnut, Package of practice recorded significantly lowest number of aphids per 2 cm shoot length per plant (2.32) whereas, the highest number of aphids was observed in Farmer's practice treatment (6.24 aphids per 2 cm shoot length per plant). The incidence of aphids on blackgram at three days after first spray revealed the lowest aphid count of 4.16 per 2 cm shoot length per plant in Package of practice, whereas, the highest in Farmer's practice (13.16 aphids per 2 cm shoot length per plant). Significantly higher number of coccinellids in groundnut and blackgram was observed in Natural farming which was on par with Organic farming after both the sprays.

Key words : *Natural farming, Organic farming, Package of practice, Groundnut, Blackgram*

Introduction

Zero Budget Natural Farming (ZBNF) is a set of farming methods and also a grassroots peasant movement which has spread to various states in India. It has attained wide success in southern India, especially the southern Indian state of Karnataka where it first evolved. The movement in Karnataka state was born out of collaboration between Mr Subhash Palekar, who put together the ZBNF practices, and the state farmers association, Karnataka Rajya Raitha Sangha (KRRS). The neoliberalization of the Indian economy led to a deep agrarian crisis that is making small scale farming an unviable vocation. Privatized seeds, inputs, and markets are inaccessible and expensive for peasants. Indian farmers increasingly find themselves in a vicious cycle of debt, because of the high production costs, high interest rates for credit, the volatile market prices of crops, the rising costs of fossil fuel based inputs, and private seeds. More than a quarter of a million farmers have committed suicide in India in the last two decades. Under such conditions, 'zero budget' farming promises to end a reliance on loans and drastically cut production costs, ending the debt cycle for desperate farmers. The word 'budget' refers to credit and expenses, thus the phrase 'Zero Budget' means without using any credit and without spending any money on purchased inputs. 'Natural farming' means farming with nature and without chemicals. In this context, the present investigation was undertaken to evaluate the efficacy of different farming systems on management of insect pests as well as their influence on the incidence of natural enemies in

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groundnut and blackgram under field conditions.

Materials and Methods

Studies on efficacy of different farming systems on management of insect pests and incidence of natural enemies in groundnut variety TMV-2 and blackgram variety Rashmi, both spaced at 30 cm x 10 cm was conducted by taking up sowing in the month of February in a plot size of 5.7 m x 5.1 m at Seed Farm, Zonal Agricultural and Horticultural Research Station, Brahmavar during *summer* 2019. The experiment was laid out in Randomized Block Design with four treatments and five replications. The four treatments included Palekar method of Natural Farming (ZBNF), Organic Farming (OF), Package of Practices (POP) and Farmer's Practice (FP). Both the crops were raised by following all the agronomic practices accordingly as per each treatment. The treatment *viz*., Farmer's Practice was based on the agronomic practices followed by the local farmers of Udupi district in general. With respect to plant protection aspects, the treatments were imposed by using knapsack sprayer with 500 liters of spray solution per hectare. Both the crop received two sprays, the first being given at 30 days after sowing and another at 45 days later based on economic threshold level of the pest. The treatment details with respect to plant protection aspects are given in Table 1.

Preparation of Neemastra: It is a neem based biorational recommended in ZBNF for the management of sucking pests in different crops. It is prepared by using 5 litres of desi cow urine, 5 kg of desi cow dung and 5 kg of neem leaf paste mixed in 100 litres of water and fermented for 24 hours. It is recommended to be sprayed directly on crops without dilution at the rate of 250 litres per hectare.

The observations on different insect pests infesting groundnut and blackgram during the study were recorded. It was observed that sucking pest *viz*., aphids were the only insect pest that crossed the economic threshold levels and damaged both the crops. Though leaf hoppers and defoliators were observed, their incidence was minor and below the threshold levels. The observations on aphids were recorded per 2 cm shoot length per plant from five randomly selected plants in each treatment at 30, 45 and 60 days after sowing which was then averaged. Observations were also recorded at 3 and 7 days after first and second sprays taken up during 30 and 45 days after sowing, respectively. The observations on natural enemies *viz*., coccinellids were recorded by counting the number of grubs, pupae and adult per plant from five randomly selected plants in each treatment. During the study, pitfall traps were used to record the population of soil macro fauna moving above the ground as per the method mentioned by Chethan and his colleagues (2019). One pitfall trap each was placed in each treatment which consisted of plastic cups (10 cm diameter and 15 cm height). The traps were buried in the ground with their rim levelled with the soil surface to facilitate wandering fauna to fall inside. Each cup was filled with 50 ml of 75% ethyl alcohol as killing agent with bit of glycerol to prevent the evaporation of alcohol. Later, the soil or debris was placed around the trap so that the area of pitfall trap matches the surrounding soil surface. Abundance of macro arthropods population was recorded at fortnightly intervals upto harvest of the crops. The data recorded was then transformed to $\sqrt{X} + 0.5$ values for statistical analysis and the mean values were subjected to Duncan's Multiple Range Test (DMRT).

Results

In case of groundnut, the results presented in Table 2 revealed that three days after first spray, the Package of practice treatment recorded significantly lowest number of aphids per 2 cm shoot length per plant (2.32) whereas, the highest number of aphids was observed in Farmer's practice treatment (6.24 aphids per 2 cm shoot length per plant). A similar trend was observed even after the second spray at 45 days after sowing. However, a gradual decline in

Table 1. Details of treatments imposed

Treatments	Plant protection chemical used	Concentration or dosage
T1- Natural Farming (ZBNF)	Neemastra	250 l/ha
T2- Organic Farming (OF)	Azadirachtin 0.03 %	3 ml/l
T3- Package of Practices (POP)	Dimethoate 30 EC	1.7 ml/l
T4- Farmer's Practice (FP)	No spray	-

the aphid population was noticed from 60 days after sowing among all the treatments. With respect to coccinellid population among different treatments, significantly highest number of coccinellids was observed in Natural farming treatment which was statistically on par with Organic farming at all days of observation after both the sprays (Table 3) whereas, significantly lowest coccinellid population was observed in Package of practice treatment throughout the observation period. A similar observation was recorded in case of soil macro arthropod population during the study. Significantly highest number of soil macro arthropods per pitfall trap was recorded in Natural farming treatment which was statistically on par with Organic farming treatment during all the fortnights of observation. The highest population of soil macro arthropods was recorded as 106.20 macro arthropods per pitfall trap in Natural farming treatment at fourth fortnight of observation. Their population was observed to decrease gradually thereafter in all the treatments (Table 4).

The results presented in Table 5 with respect to the incidence of aphids on blackgram revealed that three days after first spray, the lowest aphid count of 4.16 per 2 cm shoot length per plant was recorded in Package of practice treatment whereas the highest aphid count was recorded in Farmer's practice treatment (13.16 aphids per 2 cm shoot length per plant). A similar trend was followed at three and seven days after second spray (3.12 and 4.60 aphids per 2 cm shoot length per plant, respectively). However, a gradual decline in the aphid population was noticed from 60 days after sowing among all the treatments. Significantly higher coccinellid population during all the days of observation was recorded in Natural farming treatment which was statistically on par

Table 2. Incidence of aphids in groundnut (per 2 cm shoot length per plant) under different cultural practices

Treatments	30 DAS*	3 DAS#	7 DAS#	45 DAS*	3 DAS#	7 DAS#	60 DAS*
T1- Natural Farming (ZBNF)	6.96(2.72)^{a}	4.80(2.29)^{bc}	6.44(2.63)^{bc}	7.32(2.79)^{bc}	5.24(2.39)^{b}	6.68(2.66)^{bc}	2.44(1.69)^{ab}
T2- Organic Farming (OF)	5.40(2.41)^{a}	4.04(2.12)^{b}	5.80(2.50)^{bc}	6.96(2.73)^{bc}	4.60(2.25)^{b}	5.16(2.37)^{ab}	2.20(1.62)^{a}
T3-Package of Practice (POP)	6.12(2.56)^{a}	2.32(1.67)^{a}	4.76(2.29)^{a}	5.92(2.51)^{a}	2.08(1.60)^{a}	4.56(2.24)^{a}	1.12(1.23)^{a}
T4- Farmer's practice (FP)	5.56(2.41)^{a}	6.24(2.58)^{c}	7.52(2.82)^{c}	7.96(2.90)^{c}	7.76(2.85)^{c}	7.24(2.77)^{c}	4.08(2.13)^{b}
S. Em.±	0.14	0.10	0.11	0.10	0.12	0.12	0.16
CD @5%	NS	0.32	0.35	0.31	0.37	0.37	0.48

*- Days after sowing, # - Days after spray, Figures in the parentheses are $\sqrt{(X + 0.5)}$ transformed values, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT.
Plant protection practices followed:
ZBNF - 2 sprays of Neemastra at 30 and 45 days after sowing
OF - 2 sprays of Azadirachtin 0.03% at 30 and 45 days after sowing
POP - 2 sprays of Dimethoate 30 EC at 30 and 45 days after sowing
FP - No spray

Table 3. Population of coccinellids in groundnut (Grubs, pupae and adult per plant) under different cultural practices

Treatments	30 DAS*	3 DAS#	7 DAS#	45 DAS*	3 DAS#	7 DAS#	60 DAS*
T1- Natural Farming (ZBNF)	1.44(1.38)^{a}	1.52(1.41)^{a}	1.72(1.49)^{a}	2.04(1.58)^{a}	1.80(1.48)^{a}	1.52(1.42)^{a}	1.16(1.28)^{a}
T2- Organic Farming (OF)	1.00(1.20)^{a}	1.00(1.19)^{ab}	1.56(1.41)^{a}	1.84(1.51)^{ab}	1.72(1.47)^{a}	1.48(1.40)^{a}	1.00(1.22)^{ab}
T3-Package of Practice (POP)	0.92(1.19)^{a}	0.24(0.84)^{c}	0.32(0.89)^{b}	0.60(1.03)^{c}	0.24(0.84)^{c}	0.16(0.79)^{c}	0.00(0.71)^{c}
T4- Farmer's practice (FP)	1.20(1.29)^{a}	0.76(1.10)^{bc}	0.84(1.11)^{ab}	0.96(1.18)^{bc}	1.00(1.19)^{b}	0.76(1.10)^{b}	0.64(1.04)^{b}
S. Em.±	0.08	0.10	0.13	0.12	0.14	0.10	0.07
CD @5%	NS	0.30	0.39	0.36	0.45	0.31	0.21

*- Days after sowing, # - Days after spray, Figures in the parentheses are $\sqrt{(X + 0.5)}$ transformed values, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT.
Plant protection practices followed:
ZBNF - 2 sprays of Neemastra at 30 and 45 days after sowing
OF - 2 sprays of Azadirachtin 0.03% at 30 and 45 days after sowing
POP - 2 sprays of Dimethoate 30 EC at 30 and 45 days after sowing
FP - No spray

with Organic farming treatment. The highest coccinellid population of 2.84 grubs, pupae and adult per plant was noticed at 45 days after sowing in Natural farming treatment which further decreased as the days progressed (Table 6). The lowest coccinellid population was recorded at 60 days after sowing in all the treatments coinciding with least aphid count. With respect to soil macro arthropod population, Natural farming treatment was statistically on par with Organic farming treatment in recording significantly highest population during all the fortnights of observation whereas Package of practice treatment recorded the lowest soil macro arthropod population among all the treatments. The highest population of 85.20 macro arthropods per pitfall trap was recorded in Natural farming treatment at fourth fortnight of observation. A gradual reduction in macro arthropod population was noticed thereafter in all the treatments (Table 7).

Discussion

The sucking pest *viz*., aphid appeared simultaneously in the early stage of crop growth and their population continued to build up throughout the active vegetative stages in groundnut. Later on, a gradual decrease in their population was observed as the crop advanced into flowering stage. A similar observation in occurrence of sucking pests in blackgram was recorded by Radhika and her colleagues (2018). Aphids in groundnut preferred to attack the terminal twigs and tender parts resulting in curling of leaves and stunted growth (Kandakoor *et al.*, 2012). There are no reviews pertaining to the comparative efficacy of Natural farming, Organic farming, Package of practice and Farmers practice treatments in groundnut. However, Patgar (2020) reported that the treatment with Recommended package of practice was found to be superior over all

Table 4. Population of soil macro arthropods (per pitfall trap) in groundnut under different cultural practices

Treatments	I fortnight	II fortnight	III fortnight	IV fortnight	V fortnight	VI fortnight	VII fortnight
T1- Natural Farming (ZBNF)	26.20 (5.14)^{a}	46.80 (6.86)^{a}	71.00 (8.42)^{a}	106.20 (10.31)^{a}	80.00 (8.97)^{a}	61.20 (7.84)^{a}	53.40 (7.29)^{a}
T2- Organic Farming (OF)	25.80 (5.09)^{a}	40.60 (6.38)^{a}	76.20 (8.73)^{a}	96.80 (9.86)^{a}	75.40 (8.71)^{a}	67.40 (8.23)^{a}	45.40 (6.69)^{a}
T3-Package of Practice (POP)	10.40 (3.29)^{c}	15.60 (3.98)^{b}	23.20 (4.86)^{c}	32.00 (5.68)^{c}	25.60 (5.08)^{c}	23.40 (4.88)^{c}	16.40 (4.10)^{c}
T4- Farmer's practice (FP)	18.20 (4.31)^{b}	23.80 (4.87)^{b}	41.00 (6.41)^{b}	62.20 (7.90)^{b}	43.40 (6.61)^{b}	38.00 (6.19)^{b}	27.60 (5.26)^{b}
S. Em.±	0.25	0.31	0.36	0.24	0.20	0.21	0.35
CD @5%	0.76	0.94	1.11	0.75	0.61	0.65	1.08

Figures in the parentheses are $\sqrt{(X + 0.5)}$ transformed values, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT.

Table 5. Incidence of aphids in blackgram (per 2 cm shoot length per plant) under different cultural practices

Treatments	30 DAS*	3 DAS#	7 DAS#	45 DAS*	3 DAS#	7 DAS#	60 DAS*
T1- Natural Farming (ZBNF)	13.04(3.65)^{a}	9.20(3.11)^{b}	10.28(3.28)^{bc}	11.84(3.50)^{bc}	9.64(3.17)^{b}	7.60(2.84)^{b}	5.92(2.52)^{bc}
T2- Organic Farming (OF)	12.88(3.63)^{a}	7.32(2.78)^{b}	9.36(3.13)^{b}	11.32(3.42)^{ab}	8.12(2.93)^{b}	6.80(2.70)^{b}	5.52(2.45)^{b}
T3-Package of Practice (POP)	10.24(3.26)^{a}	4.16(2.15)^{a}	6.20(2.58)^{a}	8.52(3.00)^{a}	3.12(1.89)^{a}	4.60(2.25)^{a}	3.84(2.08)^{a}
T4- Farmer's practice (FP)	12.12(3.45)^{a}	13.16(3.68)^{c}	13.72(3.72)^{c}	15.00(3.93)^{c}	15.52(3.99)^{c}	10.28(3.28)^{c}	7.04(2.74)^{c}
S. Em.±	0.25	0.16	0.16	0.15	0.15	0.09	0.09
CD @5%	NS	0.49	0.48	0.45	0.46	0.28	0.27

*- Days after sowing, # - Days after spray, Figures in the parentheses are $\sqrt{(X + 0.5)}$ transformed values, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT.
Plant protection practices followed:
ZBNF - 2 sprays of Neemastra at 30 and 45 days after sowing
OF - 2 sprays of Azadirachtin 0.03% at 30 and 45 days after sowing
POP - 2 sprays of Dimethoate 30 EC at 30 and 45 days after sowing
FP - No spray

other treatments in recording 10.18 per cent plant damage by fall army worm in rabi Sorghum followed by agniastra 2 % (13.96 %), brahmastra 5 % (14.81 %) and neemastra 5 % (15.81 %). The present findings that application of dimethoate in the Package of practice treatment was the best among all the treatments in reducing aphid population are also in agreement with Kolhe and his colleagues (2016) who reported that imidacloprid (0.003 %) and dimethoate (0.004 %) were significantly superior for controlling sucking insect pests of groundnut. Shobharani and her colleagues (2017) revealed that seed treatment with Imidacloprid 60 FS followed by spraying of Dimethoate 30 EC effectively reduced the population of sucking pests *viz*., aphids, leaf hoppers and thrips in the blackgram field. Justin and his colleagues (2015) opined that soil application of neem cake along with spraying of neem oil 3% recorded more number of aphids/ plant in blackgram when compared to insecticides which was however significantly superior to untreated control.

The results obtained with respect to coccinellids are in line with the findings of Megha and her colleagues (2015) who reported that among all the ecosystems studied, the number of coccinellids collected were more in organic farming block (288 coccinellids /plant). Patel (2006) reported that the average population of coccinellids on organically and inorganically grown cotton was 1.70 and 0.79, respectively. Highest population of ladybird beetles in organic farming than conventional farming was also reported by Lawanprasert and his colleagues (2006). The abundance of natural enemies in organic ecosystem compare to conventional plots might be due to the non-use of chemical pesticides in organic farming system which is helpful to the existence of predatory coccinellids. Vinod and colleagues (2016) also has reported the higher abundance of natural enemies *viz*., coccinellids and spiders in organic groundnut ecosystem when compared to conventional ecosystem. The results obtained with respect to soil macro arthropods are in accordance with the findings of Chetan and collegaues (2019) who reported that organic farming system recorded the highest meso and macro arthropod population of 21.35 per 100 g of soil and 42.00 per pitfall trap, re-

Table 6. Population of coccinellids in blackgram (Grubs, pupae and adult per plant) under different cultural practices

Treatments	30 DAS*	3 DAS#	7 DAS#	45 DAS*	3 DAS#	7 DAS#	60 DAS*
T1- Natural Farming (ZBNF)	2.56(1.72)^{a}	2.40(1.70)^{a}	2.56(1.74)^{a}	2.84(1.82)^{a}	2.08(1.60)^{a}	1.76(1.50)^{a}	1.52(1.41)^{a}
T2- Organic Farming (OF)	1.88(1.53)^{a}	1.76(1.49)^{ab}	1.96(1.56)^{a}	2.32(1.68)^{ab}	1.72(1.47)^{ab}	1.68(1.47)^{a}	1.00(1.22)^{a}
T3-Package of Practice (POP)	2.00(1.58)^{a}	0.76(1.08)^{c}	0.88(1.17)^{b}	1.00(1.17)^{c}	0.32(0.89)^{c}	0.20(0.81)^{c}	0.08(0.76)^{b}
T4- Farmer's practice (FP)	2.28(1.64)^{a}	1.32(1.33)^{bc}	1.12(1.20)^{b}	1.48(1.37)^{bc}	0.92(1.17)^{bc}	0.76(1.10)^{b}	0.44(0.94)^{b}
S. Em.±	0.13	0.12	0.11	0.12	0.11	0.08	0.07
CD @5%	NS	0.36	0.34	0.36	0.35	0.25	0.21

*- Days after sowing, # - Days after spray, Figures in the parentheses are √(X + 0.5) transformed values, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT.
Plant protection practices followed:
ZBNF - 2 sprays of Neemastra at 30 and 45 days after sowing
OF - 2 sprays of Azadirachtin 0.03% at 30 and 45 days after sowing
POP - 2 sprays of Dimethoate 30 EC at 30 and 45 days after sowing
FP - No spray

Table 7. Population of soil macro arthropods (per pitfall trap) in blackgram under different cultural practices

Treatments	I fortnight	II fortnight	III fortnight	IV fortnight	V fortnight
T1- Natural Farming (ZBNF)	23.20(4.85)^{a}	39.40(6.31)^{a}	70.80(8.43)^{a}	85.20(9.25)^{a}	61.20(7.83)^{a}
T2- Organic Farming (OF)	20.60(4.56)^{a}	35.20(5.96)^{a}	68.40(8.29)^{a}	83.80(9.17)^{a}	65.40(8.10)^{a}
T3-Package of Practice (POP)	8.00(2.91)^{c}	12.00(3.52)^{c}	21.60(4.69)^{c}	31.60(5.63)^{c}	18.00(4.29)^{c}
T4- Farmer's practice (FP)	13.60(3.74)^{b}	20.80(4.57)^{b}	42.60(6.56)^{b}	63.20(7.98)^{b}	34.20(5.85)^{b}
S. Em.±	0.20	0.21	0.20	0.19	0.30
CD @5%	0.61	0.65	0.61	0.57	0.93

Figures in the parentheses are √(X + 0.5) transformed values, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT.

spectively. Hence, the organic farming system increases abundance and diversity of soil organisms and soil fertility, and it adds large amounts of organic residue inputs, which in turn increases the biological activity in soil. Among the different farming systems, organic farming recorded more population of total soil macro arthropods (147.64/15 pitfall traps) followed by integrated farming system (119.71/15 pitfall traps) and least in conventional farming system (91.90/15 pitfall traps) (Mohammad *et al.*, 2017).

Hence, it can be concluded that the Package of Practice was the best treatment among all others in managing pest populations in both groundnut and blackgram crops. However, the Natural farming and Organic farming treatments encouraged higher abundance and activity of natural enemies as well as soil macro arthropods in both the crops.

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