Research Article

EFFECTS OF DIFFERENT DOSES OF NITROGEN ON JASSID (*Amrasca biguttula biguttula* Ishida), AND RED COTTON BUG (*Dysdercus koenigii* F) POPULATION AND YIELD OF OKRA (*Abelmoschus esculentus* (L.) Moench) IN CHITWAN, NEPAL

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ABSTRACT

Insect pests such as okra jassid (*Amrasca biguttula biguttula*) and red cotton bug *(Dysdercus koenigii)* are the major crop limiting biotic constraint in okra in Nepal. Man-made fossil-based pesticides and synthetic fertilizers use are the common practices to reduce pest infestations, and to increase crop production. These synthetic agricultural practices are extremely harmful to human health, biodiversity maintenance, and the environment. The aim of this experiment was to develop an appropriate pest management protocol by adopting good agricultural practices. Higher than the recommended dose of nitrogen-based fertilizer can increase the pest and diseases infestations as well as reduce the crop yield in long-run. Hence, the main objective of this experiment was to analyze the effect of different doses of nitrogen fertilizer to the population of sucking insect pest, such as jassid, and red cotton bug. The experiment was done by using a Randomized Complete Block Design (RCBD), with five treatments (200 kg N ha^{-1}, 150 kg N ha^{-1}, 100 kg N ha^{-1}, 50 kg N ha^{-1}, 0 kg N ha^{-1}), each replicated four time. Results revealed that increase rate of nitrogenous fertilizer increase the infestation rate of jassid and red cotton bug. However, the highest yield was recorded in 200 kg N ha^{-1} followed by 150 kg N ha^{-1}, respectively. The highest benefit-cost ratio was found in 150 kg N ha^{-1} and 100 kg N ha^{-1}. It is thus suggested that optimum use of nitrogen increase the economic profit as well as reduce the pest infestation of sucking insect.

Key words: Sucking pest, fertilizer, infestation, yield

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench), commonly known as ladies finger is an annual, herbaceous plant belonging to family Malvaceae and is semi-cross pollinated in nature. Okra is cultivated mostly in tropics and sub tropic regions in the world (Osekita, 2009). The edible fruit of okra approximately contain 88% water, 2.1% protein, 0.2% fat, 8.0% carbohydrate, 1.7% fiber and 0.2% ash (Tindall, 1983). However, okra production in Nepal was 112,101.6 mt in 10,781.4 ha of land with productivity of 11.3mt/ha (MoAD, 2015-2016).

Insect pests are one of the major constraints in reducing the productivity of okra in South Asian countries (Sharma & Sharma, 2001). The okra plant is attacked by a number of insect pests, such as the shoot and fruit borer (*Earias vittella* Fab.), fruit borer (*Helicoverpa armigera* Hübner), jassid (*Amrasca biguttula biguttula* Ishida), whitefly (*Bemisia tabaci* Gen), aphid (*Aphis gossypii* Glover), red cotton bug (*Dysdercus koenigii* F.), red spider mite (*Tetranychus urticae* Koch) etc (Rao & Rajendran, 2002). Jassids, aphids, whitefly, red cotton bugs, red spider mites can damage the crops by common sucking the fluid from the okra plant. These pests suck the fluid normally from the lower portion of the leaves that can limit the crop growth as well as decrease yield (Singh, Jha, Verma, & Mishra, 2013).

Nitrogen shows overwhelming effect on the growth and yield of crops. It promotes the growth of vegetative plant parts, such as leaf, stem and increase in the protein content (Sammauria, Yadhav, & Nagar, 2009). The fresh fruit yield of okra is directly influenced by the application of 150 kg N ha^{-1} (Desai, 2014). Besides that, nitrogen level also provide congenial substratum for growth and development of sucking pest during crop growth period (Ahmed et al., 2007), and also increase the nutritional quality of crops (Magdoff, 1992).

Synthetic pesticide use rate in vegetable crops are in alarming rate (Dhital et al., 2015). These practices are extremely harmful for human health and the environment, and it also render negative impact to the pollinators (Sharma & Singhvi, 2017). Balanced use of fertilizes along with judicious use of chemical pesticides can result sustainable agricultural practices as well as reduce pest infestations (Wahab, 2009). The main objective of the study was to analyze the effect of different doses of nitrogen fertilizer to the population of sucking insect pest, such as jassid, and red cotton bug. Hence, this study aimed to develop an appropriate integrated pest management protocol by using optimum dose of nitrogenous fertilizers.

MATERIAL AND METHODS

Study site description

The experiment was conducted at the Horticultural Farm (latitude 27°38′N and longitude 84°21′E) of Agriculture and Forestry University (AFU), Rampur, Chitwan, Nepal; an elevation of 256 meter above the sea level (The Small Earth Nepal (SEN), 2011).

Experimental design and treatments

The experiment was done by using Randomized Complete Block Design (RCBD) with five treatments; 0, 50, 100, 150 and 200 Kg Nha^{-1}, each with four replicates. The individual plot size was 1.2 m × 2 m. Row to row and plant to plant spacing was maintained at 50 cm and 30cm, respectively. The details of treatments have been presented in Table (1).

Table 1. Treatments applied in the experiment field

Treatments	Treatments details
T_1	Control (0 kg Nha^{-1})
T_2	50 kg Nha^{-1}
T_3	100kg Nha^{-1}
T_4	150kg Nha^{-1}
T_5	200kg Nha^{-1}

Agronomic practices and planting materials

Okra cv 'Lady Luck' was used for this study. Seeds were sown on the first week of April. One third of recommended dose of nitrogen, full dose of phosphorous (50kg ha^{-1}) and potassium (50kg ha^{-1}) were applied as a basal dose. Two third dose of nitrogen was top-dressed at 30 days and 45 days after sowing. Different intercultural practices such as gap filling, thinning, weeding, and irrigation were done in the field from time to time during April to July, 2019.

Data collection

Five plants from each treatment plot were randomly selected for data collection. The jassid and red cotton populations were directly counted by observing the leaves from the top to the base of the sample plants from 9 to 14th week after sowing whereas yield was recorded from 50 DAS at five days interval.

Data tabulation and analysis

Microsoft Excel was used for data entry, tabulation and calculations of mean. The count data for red cotton bug population was statistically analyzed after square root transformation ($\sqrt{x + 0.5}$) (Gomez & Gomez, 1984). Data from the field experiment was statistically analyzed by using software package RSTAT version 1.1.463. Treatment means were separated by Duncan's multiple range test (DMRT) at 5% level of significance.

RESULTS

Effect of nitrogen dose on jassid population

The population of Jassid (*A. biguttula biguttula*) was recorded from first week of June i.e., 9th week after sowing to first week of July i.e., 16th week after sowing (Table 2). Jassid populations per plant were significantly varied over 13th week after sowing until harvest. However, jassid population was not significantly varied before 12 weeks after sowing.

The highest jassid population was recorded on 13th, 14th, 15th and 16th weeks after sowing in plot treated with highest doses of nitrogen and population were 108.90, 101.60, 85.05 and 72.55 respectively; whereas, the lowest jassid population 73.60, 61.30, 34.85 and 31.25 per plant was noted in control plots in the same date. Mean number of population showed highly significant variation among the treatments with highest mean population for highest nitrogen level (200kg Nha^{-1}) and lowest mean population in control (Table 2).

Table 2. Effect of nitrogen dose on jassid population

Treatments	Jassid population (No.)								
	63 DAS	70 DAS	77 DAS	84 DAS	91 DAS	98 DAS	105 DAS	112 DAS	Mean population
200Kg Nha^{-1}	29.95	35.45	58.75	87.30	108.90^{a}	101.60^{a}	85.05^{a}	72.55^{a}	72.46^{a}
150Kg Nha^{-1}	30.55	33.75	57.40	84.05	94.85^{ab}	87.75^{ab}	72.15^{b}	52.70^{b}	64.15^{b}
100Kg Nha^{-1}	24.80	33.35	51.55	83.05	91.50^{b}	78.55^{bc}	45.30^{c}	43.50^{c}	56.45^{bc}
50 Kg Nha^{-1}	22.15	28.95	50.40	77.35	86.25^{bc}	67.30^{cd}	43.45^{c}	31.80^{d}	50.96^{cd}
Control	25.85	31.55	45.00	67.4	73.60^{c}	61.30^{d}	34.85^{d}	31.25^{d}	46.51^{d}
F-test	NS	NS	NS	NS	**	***	***	***	***
S. E.	-	-	-	-	5.07	4.67	2.60	2.67	2.58
LSD	-	-	-	-	15.64	14.40	8.01	8.23	7.95
CV%	-	-	-	-	11.15	11.78	9.26	11.52	8.87

Note: DAS: days after sowing; NS: non-significant; **: significant at 0.01% probability level; ***: significant at 0.001% probability level; CV: coefficient of variation; LSD: least significant difference at 5% level of significance; Value with the same letter in a column are not significantly different at 5% by Duncan's multiple range test (DMRT) and S. E.: standard error of the means.

A positive correlation between nitrogen dose and jassid population was recorded ($R^2 = 0.86$). The coefficient of determination was 86.31% that indicates that there is strong correlation between dose of nitrogen and jassid population (Figure 1).

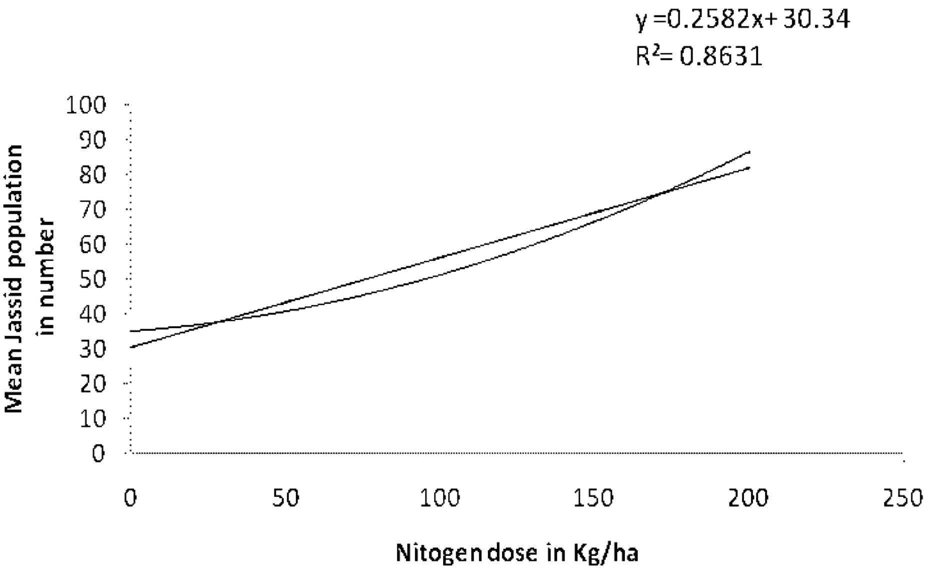

Figure 1. Jassid population at different dose of nitrogen (kg/ha)

Effect of nitrogen dose on red cotton bug population

The red cotton bug, *D. koenigii* population was recorded from 14th week after sowing to 16th week after sowing. There was highly significant variation of red cotton bug population among the treatments at 16th week after sowing. The highest population of red cotton bug was counted the highest in the treatment provided with highest nitrogen level (200kg Nha^{-1}). Similarly, the lowest mean population was observed in control (Table 3).

Table 3. Effect of nitrogen dose on red cotton bug population

Treatments	Red cotton bug population (No.)			
	98 DAS	105 DAS	112 DAS	Mean population
200Kg Nha^{-1}	1.40	1.41	3.12[a]	1.98[a]
150Kg Nha^{-1}	1.13	1.64	2.82[ab]	1.86[a]
100Kg Nha^{-1}	1.14	1.35	2.47[b]	1.65[ab]
50 Kg Nha^{-1}	1.06	1.40	1.42[c]	1.29[bc]
Control	0.84	1.06	1.27[c]	1.06[c]
Significance level	NS	NS	***	**
S. E.	-	-	0.20	0.15
LSD	-	-	0.62	0.45
CV%	-	-	18.13	18.64

Note: DAS: days after sowing; NS: non-significant; **: significant at 0.01% probability level; ***: significant at 0.001% probability level; CV: coefficient of variation; LSD: least significant difference at 5% level of significance; Value with the same letter in a column are not significantly different at 5% by Duncan's multiple range test (DMRT) and S. E.: standard error of the means.

A positive correlation between nitrogen dose and red cotton bug population was found (R^2 0.641). The coefficient of determination was 64.10% which showed the strong correlation between dose of nitrogen and red cotton bug population (Figure 2).

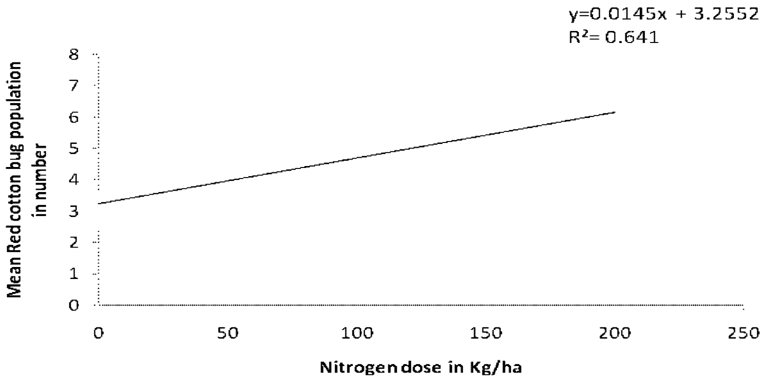

Figure 2. Red cotton bug population at different dose of nitrogen (Kg/ha)

Effect of nitrogen dose on yield

Highly significant variation on yield was found among the treatments. The highest yield was obtained with 200kg N ha^{-1} which was statistically similar with 150kg N ha^{-1} and 100kg N ha^{-1}. The lowest yield was found in control followed by 50kg Nha^{-1}(Table 4).

Table 4. Effect of nitrogen dose on yield of okra

Treatments	Total Yield(t/ha)	Percentage increase in yield over control (%)
200kg N ha^{-1}	11.20[a]	136.79
150kg N ha^{-1}	10.61[a]	124.31
100kg N ha^{-1}	10.58[a]	123.68
50 kg N ha^{-1}	6.93[b]	46.51
Control	4.73[c]	-
Significance level	***	-
S. E.	0.39	-
LSD	1.19	-
CV%	8.75	-

Note: DAS: days after sowing; NS: non-significant; **: significant at 1% probability level; ***: significant at 0.1% probability level; CV: coefficient of variation; LSD: least significant difference at 5% level of significance; Value with the same letter in a column are not significantly different at 5% by Duncan's multiple range test (DMRT) and S. E.: standard error of the means.

A positive correlation between nitrogen dose and yield was found (R^2 0.80). The coefficient of determination was 80.09% which showed the strong correlation between dose of nitrogen and yield of okra (Figure 3).

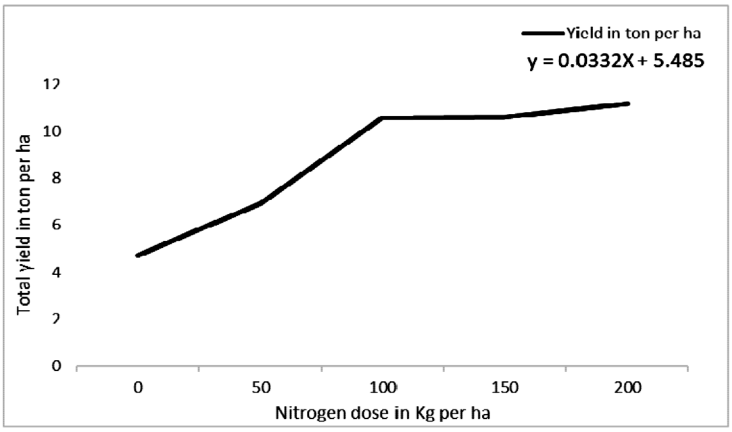

Figure 3. Yield at different level of nitrogen dose (kg/ha)

Benefit-Cost ratio

Nitrogen doses of 100 kg N ha^{-1} and 150 kg N ha^{-1} provided the highest benefit cost ratio (2.71) followed by 200 kg N ha^{-1}. Similarly, lowest BC ratio was recorded in control (0.68) (Table 5)

Table 5. Benefit-Cost ratio

Treatments	Total cost of cultivation ($/ha)	Total yield (t/ha)	Farm gate price ($/kg)	Gross income ($/ha)	Net profit ($/ha)	B:C ratio
200 kg N ha^{-1}	2000	11.20	0.66	7,392.0	5392.0	2.70
150Kg Nha^{-1}	1890	10.61	0.66	7,002.6	5112.6	2.71
100Kg Nha^{-1}	1880	10.58	0.66	6,982.8	5,102.8	2.71
50 Kg Nha^{-1}	1870	6.93	0.66	4,573.8	2703.8	1.45
Control	1860	4.73	0.66	3,121.8	1261.8	0.68

Note: $/ha indicates US dollar per hectare

DISCUSSION

Nitrogen promotes the leaf, stem, other vegetative growth of the crop plants. More vigorous growth of plants occurred in plants receiving higher nitrogen dose. Nitrogen fertilization increases rates of new leaf flushing in indeterminate plants and affect leaf development rates (Anusha et al., 2017). Many folivores (herbivores that specialize in eating leaves) typically prefer new leaf tissue because of their relatively high N content and low toughness. This might have caused higher incidence of jassids and red cotton bugs in plants receiving higher nitrogen dose. Nitrogen keeps on changing its chemical form continually, moving from plants through animal, soil, water and the atmosphere. This process of transformation of nitrogen through nitrogen cycle leads to variable status of its concentration in the soil. Higher nitrogen application through chemical fertilizer also leads to deviation in nitrogen cycle and ultimately affects to the environmental processes. A higher population of jassid and whitefly at higher nitrogen doses was recorded in okra in West Bengal (Biswas et al., 2013). The higher populations of Bt cotton sucking pests was recorded with higher nitrogen doses in cotton under both unprotected and protected conditions at RARS, Lam, Guntur (Anusha et al., 2017). Significant variation in plant growth after application of full dose nitrogen in latter weeks resulted in significant variation of pests, but only in latter weeks. Similarly, peak level of jassid incidence was also recorded at twelve week after sowing and seasonal abundance of *D. koenigii* from thirteenth week after sowing in okra in north eastern hill region of India (Boopathi et al., 2011). These information supports well to the findings of our study as well.

CONCLUSION

The population of jassid and red cotton bug in okra increases with increase in the dose of nitrogen which indicates that application of higher nitrogen dose through chemical fertilizer increase insect pest attack in okra. B:C ratio was same for 100 kg N/ha and 150 kg N/ha use. Thus, 100 kg N/ha could be the optimum dose of Nitrogen for Okra production in order to get maximum benefit with reducing insect pest population. However, in certain cases, continuous use of nitrogen fertilizer in the soil may disturb soil as well as aquatic environment that can certainly influence the local as well as peripheral biodiversity. Hence it is equally important to add some organic amendments to increase the soil health as well as to reduce chemical fertilizers.

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