Int.J.Curr.Microbiol.App.Sci (2017) *6*(9): 793-803

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 9 (2017) pp. 793-803**
Journal homepage: http://www.ijcmas.com

Original Research Article

https://doi.org/10.20546/ijcmas.2017.609.098

Impact of Different Graded Levels of Fertilizers on the Incidence of Yellow Stem Borer *Scirpophaga incertulas* (Wlk.), Leaf Folder *Cnaphalocrocis medinalis* (Guenee) and Whorl Maggot *Hydrellia philippina* (Ferino) in Paddy

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Keywords

Paddy, Yellow Stem Borer, Leaf folder, NPK, Manures.

Article Info

Accepted:
14 July 2017
Available Online:
10 September 2017

A B S T R A C T

The field experiment was conducted at Central Research Farm of Orissa University of Agriculture and Technology, Bhubaneswar during summer 2014-15 and *kharif*- 2015 to evaluate the effect of different graded levels of fertilizers and manure on incidence of yellow stem borer, leaf folder and whorl maggot in paddy with twelve treatments and four replications in sub plot size of 15m x 10m taking Lalat and Swarna as test cultivar during summer 2014-15 and *kharif* -2015 following the recommended package of practices It was observed that the incidence of borer, leaf folder and whorl maggot was enhanced with application of increased doses of NPK fertilizers. But the FYM and micronutrients with NPK nutrients recorded low incidence of borer both at vegetative (dead heart) and heading stage (white ear head), leaf folder and whorl maggot.

Introduction

Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population and accounts for more than 50% of the daily calorie intake (Khush, 2005). Insect pests and diseases pose a very serious challenge in improving the productivity and achieving sustainability. Approximately 52% of the global production of rice is lost annually owing to the damage caused by biotic stress factors, of which 21% is attributed to the attack of insect pests (Yarasi *et al.*, 2008). The overall losses due to insect damage in rice were estimated to be 25 per cent (Dhaliwal *et al.*, 2010). Out of this, 20 to 30 per cent damage is alone done by yellow stem borer, *Scirpophaga incertulas* (Walker) (Lal, 1996). However, Singh *et al.*, (2003) reported 12-18.8% yield loss due to leaf folder in irrigated rice crop. High intensity of insect pest menace coupled with inadequate and imbalanced plant nutrient use is considered as major factors of low productivity. Judicious use of NPK fertilizers is considered as vital cultural practices in the IPM strategy of rice which minimise the insect pest incidence, markedly increase the yield and improve the quality of rice. Nitrogen, phosphorus and potassium fertilizers are major essential plant nutrients of rice production. Excessive application of nitrogenous fertilizers increased the incidence of insect pests by altering morphological, biochemical and physiological characters of host plants through host selection and ecological fitness such as survival, growth, fecundity and significant reduction of host resistance against herbivores improving the nutritional conditions for herbivores (Simpson, 1990, Barbour, 1991). Phosphorus is an important component for the population growth of phytophagous insects as it is required for RNA synthesis. On the contrary, application of potassium (K) as a major plant nutrient enhances the protein synthesis and thus, reducing amino acid content in the sap there by making the plant less favourable for the reproduction of sucking pests (Samiyyan and Janathanan, 1988). Thus, fertilization not only influences the growth, development and yield of crop plants but also regulate the activities of insect pests both directly and indirectly with ultimate impact on yield. In this context, the economic doses of given nutrient, however, is to be determined critically considering its rate as plant nutrient and insect suppressant or promoter.

Materials and Methods

The field experiments were laid out during summer 2014-15 and *kharif* 2015 Randomized block design (RBD) with twelve treatments and four replications at Central Farm, OUAT, Bhubaneswar to assess the incidence of yellow stem borer (YSB), leaf folder (LF) and whorl maggot (WM) of rice raised under NPK nutrient levels with FYM and micro nutrients. The soil of the experimental plot was lateritic sandy loam.

The seedlings of rice variety Lalat and Swarna was taken as the test cultivar in summer 2014-15 and *Kharif*-2015 were planted in plots of size 15m x 10m at spacing of 20cm x 10cm with recommended agronomic practices.

Methods and time of application of manures and fertilizers

Nitrogen was applied in 3 splits *i.e.* 25% as basal, 50% at 15 days after transplanting at maximum tillering stage and 25% at panicle initiation stage. Total phosphorus and sulphur was applied as basal. Potash was applied as 50% basal and 50% at panicle initiation stage.

Boron was applied as two foliar sprays at 0.25% at panicle initiation stage and 15 days after panicle initiation. The required amount of FYM was incorporated one week before transplanting.

Sampling techniques for record of pest population

Stem borer

In vegetative stage, the total number of tillers and the dead hearts (DH) was counted in randomly selected 10 hills per subplot in replication by leaving the border lines from sides. The percentage of DH was computed from 30 DAT onwards up to 50 DAT during summer 2014-15 and up to 60DAT during *Kharif* 2015. At pre-harvest stage *i.e.*, 15 days prior to harvest, the stem borer damage was assessed by computing white ear head percentage as suggested by (Gomez, 1972).

Leaf folder

Total number of leaves and the number of damaged leaves were counted in 10 randomly selected clumps of each subplot replication wise and the percentage leaf damage was computed from 30 DAT onwards up to 80 DAT during both the seasons.

Whorl maggot

In vegetative stage, the total number of tillers and the damaged leaves were counted in10 randomly selected hills/subplot in each replication wise and the percentage leaf damage was computed from 30 DAT onwards up to 50 DAT during both the seasons.

The data thus obtained on extent of damage by stem borer (DH and WEH %), leaf folder (% leaf damage) and whorl maggot (% leaf damage) were computed and the mean data were subjected to statistical analysis after suitable transformation.

Results and Discussion

Effect of fertilizers, fertilizer combinations and manure on incidence of yellow stem borer

The data on incidence of stem borer (% DH & % WEH) during summer 2014-15 is presented in table 1, it was observed that mean % DH was lowest in T_5 (100 % NPK + FYM) followed by T_4 (100 % NPK + Zn), T_7 (100 % NPK+B+ Zn) and T_6 (100 % NPK +FYM +Lime) then rest of the treatments in which the mean % DH more than 15 %.Thus, it clearly indicated that individual nutrient or combination of nutrients *i.e.* NPK produced more DH has compared to 100% NPK supplemented with either B, Zn, & FYM that supported very few adult population of YSB. During *kharif* 2015 there was a change in trend as regards to % DH, the treatment T_7 (100 % NPK + B + Zn) produced only mean of 8.45 % DH followed by T_4 (100% NPK +Zn), T_8 (100% NPK+ S+ Zn), T_6 (100% NPK+ FYM+ Lime), T_5 (100% NPK+FYM) (Table 2). It is very clear that irrespective of season the treatments comprising 100%NPK with supplemented with Zn, B and S produced less DH as compared to rest of the treatments. This gives a clear cut idea that a constituent of FYM with balanced nutrition was responsible for low DH, which has been earlier observed by Chakraborty *et al.,* (2011). Shahjahan (1992) concluded that the infestation of yellow stem borer decreased with increase of dosage of zinc sulphate. Dash *et al.*, (2008) observed that supplementation of $ZnSO_4$ with NPK nutrients recorded low incidence of borer both at vegetative (DH) and heading stage (WEH). Sarwar (2011) and Dash *et al.*, (2011) observed decreased yellow stem borer infestation with supplementation of $ZnSO_4$. Pandal *et al.*, (1975) and Panda (1976) reported the antagonistic effect of zinc against yellow stem borer which resulted due to induced antibiosis effect of zinc and developing of hard pseudostem. Shu *et al.*, (2009) reported excess Zn made expression of vitellogenin gene down regulated and caused poor accumulation of egg yolk, which led to reduction in egg numbers and failure of eggs to hatch. Thus, the present findings derived ample support from the finding of above workers, so far the dead heart and white ear head was concerned.

Effect of fertilizers, fertilizer combinations and manure on incidence of leaf folder

The data on effect of NPK fertilizer alone or in different combination along with supplement with lime, FYM, B, S, Zn etc on the incidence of leaf folder in summer 2014-15 and *kharif* 2015 have been present in tables 3 and 4 respectively. It was observed that during summer season T_6 (100% NPK + FYM + Lime) produced lowest minimum leaf damage of 3.13 %, followed by T_5 (100% NPK + FYM), T_7 (100% NPK + B+ Zn), T_2 (100% NPK) and T_1 (100 % PK) treatments respectively. Whereas, in *kharif*- 2015 leaf damage found to be little bit high being lowest in T_7 (100 % NPK + B+ Zn) followed by T_4, T_8, T_{11} etc. The treatment T_7 consistently produced less damage by leaf folder during both years of study, which clearly indicated that 100% NPK with B and Zn accounted for least leaf folder damage. Chau *et al.,* (2005) reported reduction of 50-60% incidence of leaf folder on application of FYM at dosage of 5.0 – 7.5 t ha^{-1}. Plants sprayed with boron and zinc chelates lowered the incidence of leaf folder as earlier reported by Premila *et al.,* (1984). Hyrsl *et al.,* (2007) reported that boric acid has adverse effect on survival, development and fecundity of insects. Hence, the present finding is well supported by above findings.

Table.1 Incidence of yellow stem borer (DH %) and (WEH %) in rice during summer 2014-2015, at Bhubaneswar

Treatments	Incidence of DH (%) at			Mean (%) DH	WEH (%)
	30 DAT	40DAT	50DAT		
T_1- 100% PK	20.96 (4.54)	21.92 (4.72)	22.30 (4.76)	21.72	8.15 (2.99)
T T_2- 100% NPK	19.15 (4.42)	20.77 (4.60)	21.90 (4.72)	20.60	7.35 (2.64)
T_3-150% NPK	20.94 (4.70)	21.42 (4.67)	22.20 (4.76)	21.52	7.93 (2.89)
T_4-100% NPK+ Zn	10.33 (3.20)	11.46 (3.38)	12.45 (3.52)	11.41	6.67 (2.67)
T_5-100% NPK+FYM	9.10 (3.13)	10.73 (3.27)	11.63 (3.40)	10.73	6.26 (2.59)
T_6-100% NPK+ FYM + Lime	12.49 (3.59)	13.85 (3.78)	14.46 (3.86)	13.60	5.30 (2.41)
T_7-100% NPK +B + Zn	11.03 (3.31)	12.03 (3.46)	13.03 (3.60)	12.03	6.67 (2.67)
T_8-100% NPK + S+ Zn	16.38 (4.10)	17.85 (4.27)	18.70 (4.34)	17.64	6.46 (2.61)
T_9-100% N	24.23 (4.96)	24.95 (5.04)	28.40 (4.84)	25.86	11.82 (3.50)
T_{10}-100% NP	21.33 (4.62)	22.67 (4.80)	23.00 (4.84)	22.33	9.75 (3.19)
T_{11}-100% NPK + Lime	17.05 (4.35)	18.91 (4.59)	20.45 (4.59)	18.80	6.95 (2.71)
T_{12}- Control	25.90 (5.13)	27.12 (5.25)	29.27 (5.48)	27.43	14.40 (3.85)
SE (m) ±	0.06	0.06	0.32	-	0.07
CD (5%)	0.19	0.17	0.92	-	0.21
CV (%)	3.10	2.78	14.44	-	5.01

Figures in parenthesis are √(x+0.5) transformed values. 100% NPK = 80:40:60 kg $ha^{-}1$(N: P_2O_5:K_2O); FYM = 5 t ha^{-1}; Lime = 1 t $ha^{-1;}$ Zn = 12.5 kg Zn SO_4 $ha^{-1;}$ B = 0.25%; S = 30 kg gypsum ha^{-1}.

Table.2 Incidence of yellow stem borer (DH %) and (WEH %) in rice during *kharif* -2015, at Bhubaneswar

Treatments	Incidence of DH (%) at				Mean (% DH)	WEH (%)
	30 DAT	40DAT	50DAT	60DAT		
T_1- 100% PK	11.21 (3.41)	12.40 (3.58)	12.87 (3.62)	13.45 (3.73)	12.48	4.12 (2.13)
T T_2-100% NPK	10.32 (3.25)	11.07 (3.39)	11.27 (3.42)	11.67 (3.48)	11.08	3.62 (2.02)
T_3-150% NPK	11.21 (3.41)	12.17 (3.55)	12.50 (3.60)	12.70 (3.62)	12.14	3.85 (2.08)
T_4-100% NPK+ Zn	7.62 (2.84)	9.20 (3.11)	9.40 (3.13)	10.35 (3.28)	9.14	2.92 (1.84)
T_5-100% NPK+ FYM	9.59 (3.16)	10.70 (3.34)	10.67 (3.33)	10.90 (3.36)	10.46	3.42 (1.96)
T_6-100% NPK+ FYM + Lime	9.09 (3.09)	10.50 (3.31)	10.15 (3.17)	9.77 (3.20)	9.89	3.22 (1.92)
T_7-100% NPK +B + Zn	7.42 (2.79)	8.42 (2.98)	8.62 (3.01)	9.35 (3.13)	8.45	2.90 (1.81)
T_8-100% NPK + S+ Zn	8.79 (2.96)	9.57 (3.12)	9.50 (3.37)	10.45 (3.30)	9.57	3.02 (1.86)
T_9-100% N	12.23 (3.52)	13.30 (3.69)	13.47 (3.57)	14.02 (3.80)	13.25	5.67 (2.48)
T_{10}-100% NP	11.79 (3.53)	13.30 (3.71)	13.35 (3.71)	13.87 (3.78)	13.07	4.42 (2.21)
T_{11}-100% NPK + Lime	9.73 (3.13)	10.80 (3.33)	10.45 (3.30)	10.52 (3.31)	10.28	3.37 (1.82)
T_{12}- Control	14.36 (3.86)	15.30 (3.97)	15.30 (3.97)	15.50 (3.99)	15.12	7.42 (2.80)
SE (m) ±	0.09	0.09	0.10	0.07	-	0.08
CD (5%)	0.26	0.25	0.29	0.20	-	0.24
CV (%)	5.54	4.98	5.78	4.00	-	7.89

Figures in parenthesis are $\sqrt{(x+0.5)}$ transformed values. 100% NPK = 80:40:60 kg $ha^{-}1$(N: P_2O_5:K_2O); FYM = 5 t $ha^{-1;}$ Lime = 1 t $ha^{-1;}$ Zn = 12.5 kg Zn SO_4 $ha^{-1;}$ B = 0.25%; S = 30 kg gypsum ha^{-1}.

Table.3 Incidence of leaf folder in rice during summer 2014-2015, at Bhubaneswar

Treatments	Incidence of LF (%) at				Mean (%) leaf damage
	50 DAT	60DAT	70DAT	80DAT	
T_1- 100% PK	3.07 (1.87)	3.62 (2.03)	3.60 (2.21)	4.05 (2.13)	3.58
T T_2- 100% NPK	2.87 (1.80)	3.07 (1.88)	3.95 (2.10)	4.42 (2.22)	3.57
T_3-150% NPK	5.32 (2.40)	6.22 (2.63)	6.72 (2.67)	7.55 (2.83)	6.45
T_4-100% NPK+ Zn	4.07 (2.13)	5.02 (2.29)	5.70 (2.48)	6.90 (2.72)	5.42
T_5-100% NPK+FYM	2.50 (1.74)	2.57 (1.75)	4.72 (2.26)	3.77 (2.32)	3.39
T_6-100% NPK+ FYM + Lime	2.55 (1.74)	2.72 (1.79)	3.47 (1.99)	3.80 (1.87)	3.13
T_7-100% NPK +B + Zn	2.65 (1.76)	2.97 (1.86)	3.77 (2.01)	4.22 (2.17)	3.40
T_8-100% NPK + S+ Zn	3.07 (1.88)	4.37 (2.20)	4.87 (2.31)	5.70 (2.48)	4.50
T_9-100% N	5.60 (2.45)	6.80 (2.69)	7.05 (2.72)	8.45 (2.98)	6.97
T_{10}-100% NP	5.47 (2.30)	6.60 (2.65)	7.40 (2.81)	7.82 (2.88)	6.82
T_{11}-100% NPK + Lime	2.80 (1.83)	3.17 (2.08)	3.92 (2.32)	4.35 (2.29)	3.56
T_{12}- Control	5.00 (2.34)	6.00 (2.55)	6.25 (2.54)	7.15 (2.71)	6.10
SE (m) ±	0.08	0.08	0.10	0.05	-
CD (5%)	0.25	0.25	0.29	0.16	-
CV (%)	8.86	8.07	8.70	4.76	-

Figures in parenthesis are $\sqrt{(x+0.5)}$ transformed values. 100% NPK = 80:40:60 kg $ha^{-}1$(N: P_2O_5:K_2O); FYM = 5 t $ha^{-1;}$ Lime = 1 t $ha^{-1;}$ Zn = 12.5 kg Zn SO_4 $ha^{-1;}$ B = 0.25%; S = 30 kg gypsum ha^{-1}.

Table.4 Incidence of leaf folder in rice during *kharif* – 2015, at Bhubaneswar

Treatments	**Leaf damage (%) at**				**Mean(%) leaf damage**
	50 DAT	**60DAT**	**70DAT**	**80DAT**	
T_1- 100% PK	8.15 (2.92)	7.95 (2.89)	8.14 (2.92)	10.61 (3.32)	8.71
T T_2- 100% NPK	6.15 (2.56)	7.03 (2.70)	6.96 (2.72)	6.80 (2.69)	6.73
T_3-150% NPK	6.15 (2.54)	7.28 (2.78)	7.03 (2.70)	8.76 (3.03)	7.30
T_4-100% NPK+ Zn	5.10 (2.35)	4.53 (2.24)	5.06 (2.35)	4.68 (2.27)	4.84
T_5-100% NPK+FYM	5.75 (2.49)	6.03 (2.55)	6.74 (2.65)	6.68 (2.67)	6.30
T_6-100% NPK+ FYM + Lime	5.50 (2.44)	5.12 (2.35)	5.64 (2.46)	6.22 (2.58)	8.62
T_7-100% NPK +B + Zn	5.10 (2.34)	4.29 (2.18)	4.96 (2.33)	4.61 (2.25)	4.74
T_8-100% NPK + S+ Zn	5.30 (2.38)	4.95 (2.33)	5.56 (2.45)	5.99 (2.54)	5.45
T_9-100% N	10.90 (3.35)	11.33 (3.42)	10.56 (3.32)	12.99 (3.67)	11.44
T_{10}-100% NP	9.95 (3.20)	10.78 (3.28)	9.60 (3.16)	11.61 (3.47)	10.48
T_{11}-100% NPK + Lime	5.60 (2.45)	5.28 (2.46)	6.31 (2.60)	6.49 (2.63)	5.92
T_{12}- Control	10.36 (3.32)	10.91 (3.36)	10.66 (3.22)	12.03 (3.53)	10.91
SE (m) ±	0.14	0.11	0.13	0.06	-
CD (5%)	0.41	0.33	0.37	0.19	-
CV (%)	10.45	8.35	9.34	4.45	-

Figures in parenthesis are $\sqrt{(x+0.5)}$ transformed values. 100% NPK = 80:40:60 kg $ha^{-}1$(N: P_2O_5:K_2O); FYM = 5 t $ha^{-1;}$ Lime = 1 t $ha^{-1;}$ Zn = 12.5 kg Zn SO_4 $ha^{-1;}$ B = 0.25%; S = 30 kg gypsum ha^{-1}.

Table.5 Incidence of whorl maggot in rice during summer 2014- 2015, at Bhubaneswar

Treatments	leaf infestation (%) at			Mean (%) leaf damage
	30 DAT	**40DAT**	**50DAT**	
T_1- 100% PK	1.66 (1.46)	1.96 (1.56)	2.29 (1.65)	1.97
T T_2- 100% NPK	1.72 (1.48)	1.82 (1.51)	2.35 (1.64)	1.96
T_3-150% NPK	1.82 (1.51)	1.90 (1.54)	2.22 (1.64)	1.98
T_4-100% NPK+ Zn	1.54 (1.42)	1.68 (1.46)	1.70 (1.48)	1.64
T_5-100% NPK+FYM	1.66 (1.46)	1.77 (1.50)	1.88 (1.54)	1.77
T_6-100% NPK+ FYM + Lime	1.61 (1.43)	1.70 (1.47)	1.73 (1.49)	1.68
T_7-100% NPK +B + Zn	1.52 (1.41)	1.62 (1.45)	1.67 (1.47)	1.60
T_8-100% NPK + S+ Zn	1.60 (1.44)	1.67 (1.47)	1.71 (1.48)	1.66
T_9-100% N	2.04 (1.59)	2.15 (1.62)	2.35 (1.69)	2.18
T_{10}-100% NP	2.19 (1.63)	2.31 (1.67)	2.40 (1.72)	2.30
T_{11}-100% NPK + Lime	1.63 (1.46)	1.72 (1.48)	1.85 (1.52)	1.73
T_{12}- Control	2.27 (1.66)	2.41 (1.70)	2.50 (1.69)	2.39
SE (m) ±	0.02	0.02	0.02	-
CD (5%)	0.07	0.05	0.07	-
CV (%)	3.10	2.14	3.09	-

Figures in parenthesis are √ (x+0.5) transformed values. 100% NPK = 80:40:60 kg ha^{-}1(N: P_2O_5:K_2O); FYM = 5 t ha$^{-1;}$ Lime = 1 t ha$^{-1;}$ Zn = 12.5 kg Zn SO_4 ha$^{-1;}$ B = 0.25%; S = 30 kg gypsum ha^{-1}.

Table.6 Incidence of whorl maggot in rice during *kharif* – 2015, at Bhubaneswar

Treatments	leaf infestation (%) at			Mean (%) leaf damage
	30 DAT	40DAT	50DAT	
T_1- 100% PK	0.80 (1.13)	1.17 (1.29)	1.17 (1.29)	1.04
T T_2- 100% NPK	1.42 (1.37)	1.42 (1.38)	1.67 (1.46)	1.50
T_3-150% NPK	1.55 (1.42)	1.67 (1.46)	1.82 (1.51)	1.68
T_4-100% NPK+ Zn	1.35 (1.35)	1.50 (1.41)	1.57 (1.43)	1.47
T_5-100% NPK+FYM	0.71 (1.09)	1.00 (1.31)	1.17 (1.29)	0.96
T_6-100% NPK+ FYM + Lime	0.72 (1.10)	1.20 (1.31)	1.22 (1.31)	1.04
T_7-100% NPK +B + Zn	0.92 (1.19)	1.30 (1.33)	1.30 (1.36)	1.17
T_8-100% NPK + S+ Zn	1.17 (1.26)	1.35 (1.35)	1.42 (1.38)	1.31
T_9-100% N	1.65 (1.52)	1.72 (1.48)	2.15 (1.62)	1.84
T_{10}-100% NP	1.77 (1.50)	2.05 (1.58)	2.33 (1.67)	2.05
T_{11}-100% NPK + Lime	1.45 (1.40)	1.55 (1.42)	1.72 (1.48)	1.57
T_{12}- Control	0.80 (1.13)	1.17 (1.26)	1.05 (1.24)	1.00
SE (m) ±	0.05	0.05	0.03	-
CD (5%)	0.13	0.13	0.10	-
CV (%)	7.21	6.61	4.89	-

Figures in parenthesis are $\sqrt{(x+0.5)}$ transformed values. 100% NPK = 80:40:60 kg ha^{-}1(N: P_2O_5:K_2O); FYM = 5 t $ha^{-1;}$ Lime = 1 t $ha^{-1;}$ Zn = 12.5 kg Zn SO_4 $ha^{-1;}$ B = 0.25%; S = 30 kg gypsum ha^{-1}.

Effect of fertilizers, fertilizer combinations and manure on incidence of whorl maggot

The data on incidence of whorl maggot during summer 2014-15 is presented in table 5. It was observed that (%) leaf damage was lowest in T_7 (100% NPK + B+ Zn) followed by T_4 (100% NPK + Zn), T_8 (100% NPK + S+ Zn) and T_6 (100% NPK + FYM+ Lime) than the rest of treatments. Thus, it clearly indicated that either individual nutrient or combination of nutrients *i.e.* NPK produced more (%) leaf damage as compared to 100% NPK supplemented with either B, Zn, S and FYM. During *kharif*- 2015 there was a change in trend as T_5 (100% NPK + FYM) produced 0.96 % leaf damage followed by T_6 (100% NPK + FYM+ Lime) with 1.04 % leaf damage, T_1 (100% PK) with 1.04 % leaf damage and T_7 (100% NPK + B+ Zn) with 1.17% leaf damage (Table 6). Thus, treatments comprising of 100% NPK with supplements like Zn, FYM etc reduced the incidence of (%) leaf damage as compared to rest of treatments. There is no record available in literature to substantiate the present finding could be traced in literature.

The study has demonstrated that individual nutrient or combination of nutrients *i.e.* NPK produced more pest incidence compared to application of nutrients (NPK) along with combination of micronutrients had decreased the incidence of yellow borer, leaf folder and whorl maggot. So judicious use NPK fertilizers is considered as vital cultural practices in the IPM strategy of rice which minimise the insect pest incidence, markedly increase the yield and improve the quality of rice.

Acknowledgements

Authors acknowledge the OUAT for the support to undertake this study through its Long Term Fertilizer Effect (LTFE) project (AICRP).

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How to cite this article:

Madhuri, G., P.C. Dash and Pruthvi, P. 2017. Impact of Different Graded Levels of Fertilizers on the Incidence of Yellow Stem Borer *Scirpophaga incertulas* (Wlk.), Leaf Folder *Cnaphalocrocis medinalis* (Guenee) and Whorl Maggot *Hydrellia philippina* (Ferino) in Paddy. *Int.J.Curr.Microbiol.App.Sci.* 6(9): 793-803. doi: https://doi.org/10.20546/ijcmas.2017.609.098