RESEARCH ARTICLE

MONITORING OF INSECTICIDE RESISTANCE ON BROWN PLANTHOPPER, *NILAPARVATA LUGENS* STAL. POPULATION OF PRONE AREA IN CHHATTISGARH PLAIN

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Abstract: Monitoring of insecticide resistance on brown planthopper, *Nilaparvata lugens* Stal. population of prone area in Chhattisgarh plain was carried out during kharif 2009 and 2010. The field collected insects were reared for 5 generations in Entomology greenhouse before conducting toxicity tests. Susceptibility of 7-9 day old nymphs was assessed by spraying the commercial formulations of different group of insecticides at various concentrations on TN-1 plants upto runoff stage and observed the mortility after 24, 48 and 72 hrs. of spraying.The level of insecticide resistance in field population of percent mortalitypresented in form of resistance ratio (RR)(mortality of field population**(**RR_R& RR_D)/mortality of greenhouse population) was worked out.During 2009, the highest RRof Raipur and Dhamtari BPH population was noticed (1:0.22) and (1:0.04)in buprofezin, respectively and lowest in chlorpyriphos + cypermethrin and fipronil (1:1.0) in Raipur whileDhamtari in fipronil.During 2010, the maximum RR of Raipur and Dhamtari population was recorded (1:0.15) and (1:0.04)in cypermethrin and buprofezin, respectively However, minimum population of Raipur BPH was(1:1.0)in fipronil and carbaryl and (1:0.98)in Dhamtari, respectivelywithin 72 hrs. of spraying.On the basis of two years pooled mean, the maximum RR of Raipur BPH was noticed (1:0.27) in cypermethrin whileDhamtariin buprofezin followed by imidacloprid (1:043), respectively. Whereas, the minimum population of Raipur exhibited in carbaryl (1:097)andDhamtari (1:098)in fipronil within 72 hrs. of spraying.TheRR indicates that the minimumwas observed in buprofezin followed bycypermethrinand imidacloprid. On the basis of information generated on field population of BPH revealed that it had developed considerable level of resistance against buprofezin,cypermethrin and imidacloprid. However, buprofezin is having different mode of action for controlling of BPH.

Keywords: Rice, Newer insecticides, Insecticide resistance, Relative efficacy of insecticide, *Nilaparvata lugens*

INTRODUCTION

Rice stands first among all food grain crops of the world and is the staple food of more than half of world's population. In the world, about 90 % rice produced and has been consumed in Asian region. Rice is attacked by 385 species of insects causing 31.5 to 86.0% losses in yield as reported by Gunathilagaraj and Kumar (1997). Nagata *et al.*1974reported the first documented case of insecticide resistance in BPH to BHC. In Taiwan, the BPH was developed resistance to MIPCand MTMC (Lin *et al*. 1979).Most of the hopper burned fields observed in India, Indonesia, Philippines, and Sri Lanka received the insecticides before outbreak. Detailed investigations have been made in the past few years on the insecticide induced BPH resurgence in rice (Chelliah 1979; Chelliah and Heinrichs 1980; Raman 1981; Heinrichs *et al*. 1982a; and Reissig *et al.* 1982a, b). Suppression of natural enemies following intensive broad-spectrum insecticide application was suggested as an important factor for BPH resurgence in rice (Kiritani, 1972; Kiritani *et a1.*, 1971; Kobayashi, 1961; and Miyashita, 1963).Raman (1981) showed that other resurgence inducing insecticides such as quinalphos, cypermethrin, fenthion, permethrin, and fenvalerate also increased the BPH feeding rate.Ghosh *et al*. (2010) evaluated the seven insecticidal treatments *viz.*, buprofezin 25 SC, imidacloprid 17.8 SL in two doses, thiamethoxam 25 WG, acetamiprid 20 SP, acephate 75 SP in the field against BPH, during *kharif*, 2007 and 2008. The results were revealed that buprofezin 25 SC @ 200g *a.i.*/ha and imidacloprid 17.8 SL @ 50 g *a.i.*/ha showed superiority over other insecticides by reducing the BPH population of 99.13 and 94.97%, respectively over control.Lakshmi *et al*. (2010) had studied on the development of insecticide resistance in *Nilaparvata lugens*Stal. (BPH) and *Sogatella furcifera*Horvath (WBPH) during 2004 and 2006. The resistance ratios (RR) for neonicotinoid compound *viz.*, imidacloprid, thiamethoxam and clothianidin were 35.1, 10.8, and 4.9 ppm indicating high levels of insecticide resistance, respectively. However, BPH remained susceptible to phenyl-pyrazole group *viz.*,fipronil and ethiprole with RR values of 0.9 and 0.6 ppm, respectively during 2004. During 2006, BPH in Godavari delta was exhibited increased resistance to neonicotinoids with RR values of 64.9, 17.9 and 13.2 ppm for imidacloprid, thiamethoxam and clothianidin, respectively and continued to remain susceptible to phenyl pyrazoles (fipronil and ethiprole) and organophosphates (acephate and monocrotophos). However, BPH exhibited low to moderate resistance to BPMC and carbamates.

MATERIALS AND METHODS

Investigation was carried out at the Entomology Green House of Indira Gandhi krishi vishwavidylaya,

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Raipur during of 2009 and 2010.

Sampling technique

Field population

Adult insects of brown plant hopper *N. lugens* were collected from farmers' fields in 10 villages in Raipur and 10 villages in Dhamtari district. Approximately, 300 healthy unparasitized adults of BPH were collected from each village. The insects were separated manually with the help of an aspirator from the base of rice plants and placed into test tubes covered with nylon mesh. BPH from all the villages of Raipur were pooled and designated as R-BPH and similarly the insects from Dhamtari villages were pooled and designated as D-BPH. Representative population of BPH were brought to the greenhouse and transferred immediately onto clean potted TN1 plants and placed inside the rearing cages. The collection cages were then labelled with the respective collection dates, location names and geographic positions and rearing of BPH up to 5-6 generations before these were tested for their susceptibility/resistance to different insecticides. The insects were collected two times *i.e.* during *kharif* 2009 and *kharif* 2010seasons.

Greenhouse population

The susceptible population was maintained in the glass house from the mass culture of BPH approximately since last 20 years as susceptible population for the comparison with field populationwithout any exposure to insecticides.Ready to use formulations of different groups of insecticide compounds *vz.,* Neonicotinoid - imidacloprid 17.8 SL @ 0.25ml, Carbamate - carbaryl 50 WDP @ 3.00ml, Synthetic pyrethroids - cypermethrin 25 EC @ 0.50ml, Growth regulator - buprofezin 25 SC @ 0.80ml, and Organophosphate + Carbamate **-** Chlorpyriphos 50 EC + Cypermethrin 5 EC (insecticide mixtures)@ 2.00ml/L water. The insecticides were diluted as per their recommended concentrations for field use with tap water and sprayed up to runoff stage. Observations on mortality were recorded after 24, 48, and 72 hours of exposure. The insects unable to move when toughed with camel hairbrush were considered as dead insects.BPH population counts were calculated in the form of per cent mortality. Data obtained from Completely Randomize Design (CRD) experiments were analyzed statistically as per the procedure standardized by Cocharan and Cox (1957).The percentage mortalities were computed and the level of insecticide resistance in field population of BPH was assessed by computing resistance ratio (RR):

Where, $RR = \frac{\text{Mortality of field population}}{\text{Mortaliy of greenhouse population}}$

RESULTS AND DISCUSSION

The bioefficacy tested of some popular insecticides against BPH population presented in the form of resistance ratiois presented in table –1&2, fig-1, 2, 3 &4 and plate-1, the observations recorded at periodical intervals.During 2009, the highest resistance ratio of Raipur and Dhamtari BPH population was noticed 1:0.22,1:0.24, 1:0.32, and 1:0.04,1:0.32, 1:0.46, in buprofezin, respectively Whereas, lowest in chlorpyriphos + cypermethrin and fipronil 1:1at Raipur and 1:0.96, at 24 hrs. and 1:1at 48 and 72 hrs. of spraying in Dhamtari BPH, respectively. During 2010, the maximum resistance ratio of Raipur and Dhamtari population was recorded 1:0.15,1:0.26, 1:0.30 and 1:0.04,1:0.36, 1:0.42, in cypermethrin and buprofezin, at 24, 48 and 72 hrs. of spraying, respectively with the minimum in chlorpyriphos + cypermethrin and fipronil i.e. 1:091 at 24 hrs. and 1:0.96 at 48, & 1:1 in both fipronil and carbaryl at 72 hrs. of spraying,, respectively in Raipur BPH and 1:0.96 at 24 & 48 hrs. and 1:0.98, at 72of spraying in Dhamtari, respectively. On the basis of two years, the maximum resistance ratio of Raipur BPH population was noticed 1:0.21 and 1:0.33in cypermethrin at 24 & 72 hrs. of spraying, 1:0.28 in cypermethrin andbuprofezin at 48 hrs. of spraying, respectively while, Dhamtari populationwas observed 1:0.04,1:0.34 &1:0.44 in buprofezin at 24, 48 and 72 hrs. of spraying, respectively. Whereas, the minimum in chlorpyriphos + cypermethrin and fipronil i.e. 1:096 at 24 hrs. and 1:0.98 & 1:1 at 48, 72 hrs. of spraying, respectively in Raipur BPH and 1:0.96, 1:0.98& 1:0.99 in fipronil at 24,48 & 72hrs. of spraying in Dhamtari, respectively.

The computation of some popular insecticides against different population of BPH resulted the resistance ratio indicates that imidacloprid showed the highest (1:0.50) resistance ratio in Raipur BPH population with minimum (1:0.43) in Dhamtari population. Fipronil had the highest resistance ratio of (1:0.98) in Dhamtari population with minimum (1:0.96) in Raipur population. Cypermethrin recorded the highest resistance ratio (1:0.81) in Dhamtari population and minimum (1:0.27) in Raipur population. Carbaryl noticed the highest resistance ratio (1:0.97) in Raipur population and minimum (1:0.68) in Dhamtari population. Buprofezin exhibited the highest resistance ratio (1:0.30) in Raipur population whereas, minimum (1:0.27) in Dhamtari population. Chlorpyriphos + cypermethrin also showed the highest resistance ratio (1:0.95) in Raipur population and minimum (1:0.79) in Dhamtari population.

Thus, it is clearly indicated, that Raipur population of BPH showed no resistance to cypermethrin unlike Dhamtari population with low level of resistance. In general, the level of resistance to BPH against imidacloprid and buprofezin in Raipur population and cypermethrin in Dhamtari population during 2011-12 was in increasing magnitude as compared to 2010-11. The information generated in the current study indicated that BPH developed considerable resistance to imidacloprid during 2010-11 and 2011-12 in Chhattisgarh plain. However, there was no appreciable development of resistance to fipronil and carbaryl unlike imidacloprid, cypermethrin and buprofezin. This may be due to extensive use of imidacloprid against BPH as compared to the other insecticides. However, cypermethrin showed resistance in Raipur and was non-responsive in Dhamtari population. The level of resistance to imidacloprid and cypermethrin appeared due to direct selection pressure of this insecticide without any scientific advice. Kiritani (1979) had demonstrated that the most commonly used method of controlling BPH is the application of insecticides which cause several problems such as development of insecticide resistance to pest insects, environmental pollution and undesirable effects on non-target organisms. Development of pesticide resistance in any pest is an unavoidable consequence. Several new products are being developed and evaluated to find suitable products/combinations for mitigating this pest effectively as reported by David and Shankar (2008). Wang *et al.*, 2008 and Wen *et al.*, 2009 observed very high level of resistance in field population of BPH to imidacloprid (up to 811 times) in different provinces of China. The intensive and extensive use of imidacloprid and cypermethrin in endemic areas and migration of the insect to other areas followed by spraying of the same chemical even in those non- traditional areas resulted in the insecticide resistance. Discontinuation of the use of insecticides may not solve the problem. Wang *et al.* (2009a) observed that even after stopping the selection pressure on imidacloprid showed resistance to BPH for 17 generations wherein the population did not revert to its original susceptibility level. Instead, a moderate and stable resistance level to imidacloprid was retained in the BPH population. Later, when the imidacloprid exposure was resumed to that population, it resulted in ascending levels of imidacloprid resistance in BPH at each generation. This also emphasizes the need for not only rational use of imidacloprid but also adoption of strict IRM and IPM practices in managing BPH. The insecticides belonging to phenyl pyrazole group *viz.*, fipronil and ethiprole exhibit entirely different mode of action i.e. by acting as potential blockers of GABA regulated chloride channel in nerve membranes of insect central nervous system, which is very much different from neonicotinoids. This might be the reason for no resistance to phenyl pyrazoles in neonicotinoid resistant BPH population from Raipur and Dhamtari districts of C.G. However, other reports by the same team indicated moderate level of resistance to fipronil (Wang *et al.*, 2008 and 2009b). This signals a need for cautious approach in assessment and management of resistance to fipronil also in BPH in India.

In summary, it is presented in the form of resistance ratio which indicates that the minimum resistance ratio was observed in buprofezin followed bycypermethrinand imidacloprid at 24hrs., 48hrs. and 72hrs. after spraying. On the basis of information generated on field population of BPH studies revealed that that it had developed considerable level of resistance against buprofezin, cypermethrin and imidacloprid. However, buprofezin is having different mode of action for controlling of BPH.

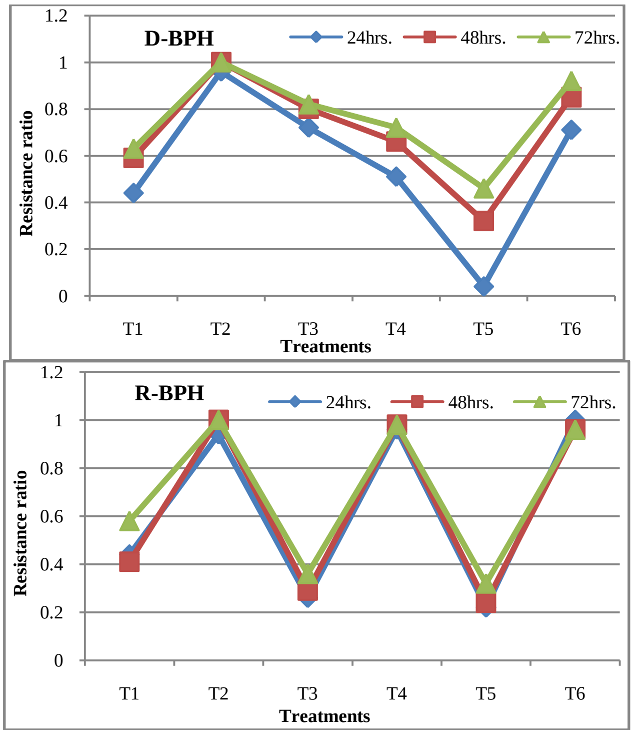

Fig 1. Resistance ratio of R and D- BPH population against different insecticide periods after release during 2009

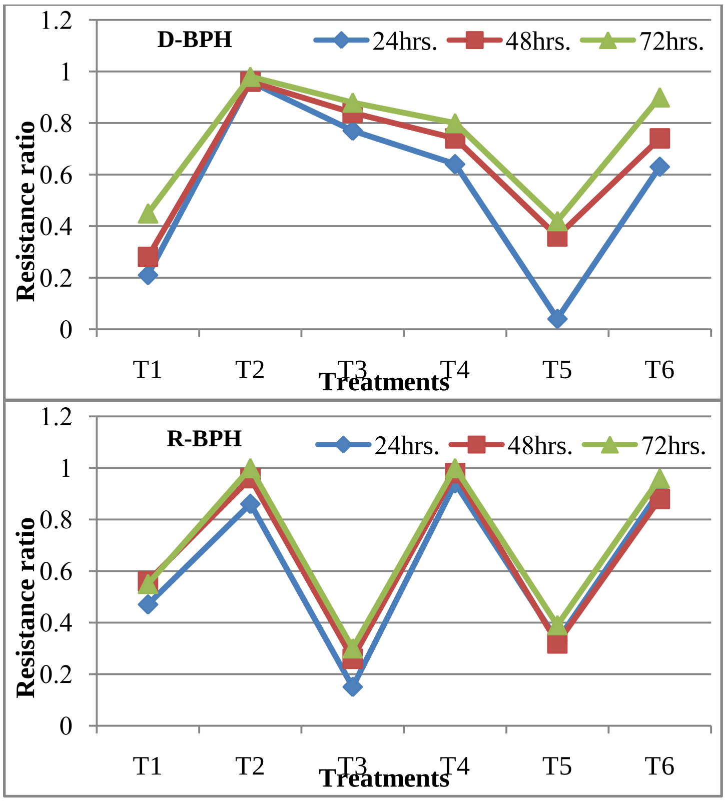

Fig 2. Resistance ratio of R and D- BPH population against different insecticide periods after release during 2010

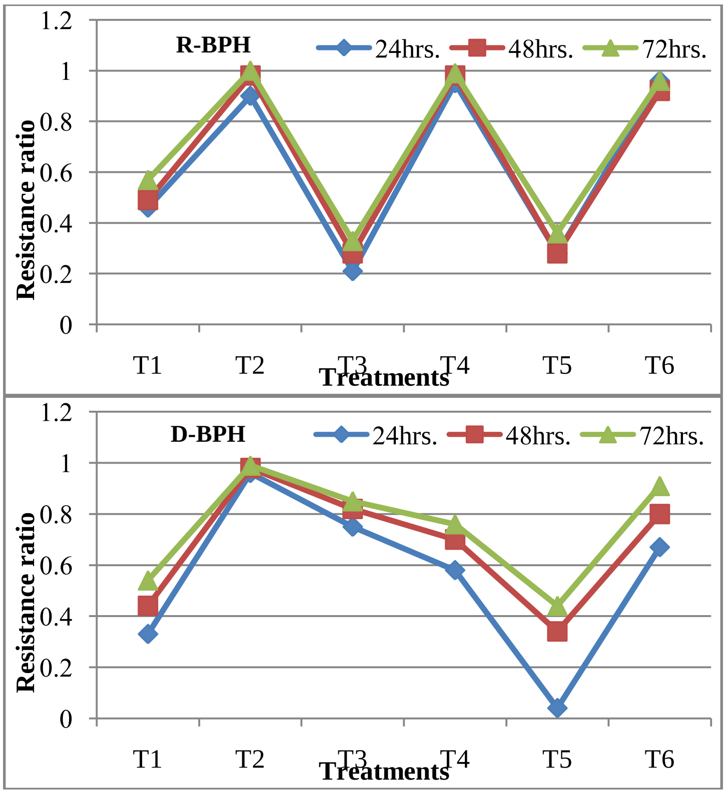

Fig 3. Mean data of R and D- BPH population against different insecticide periods after release during 2009&2010

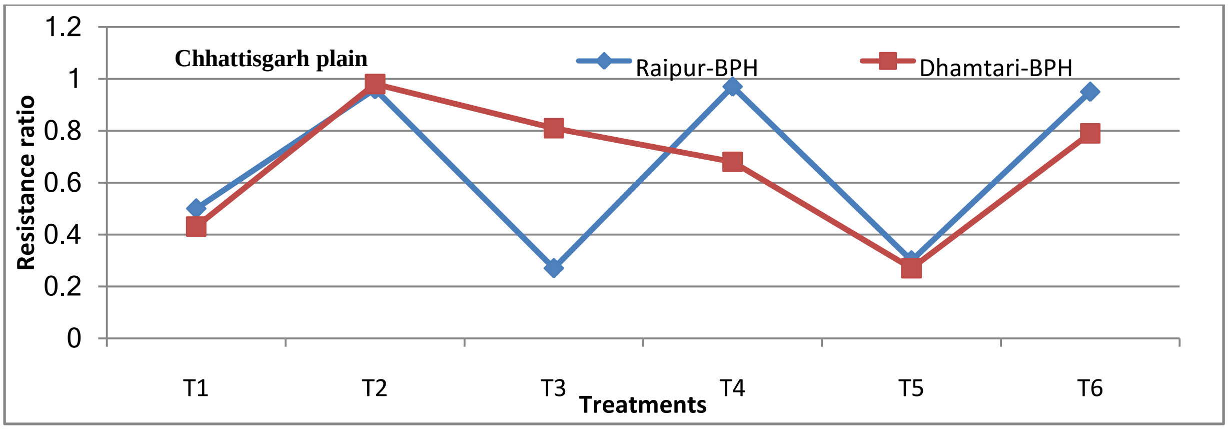

Fig 4. Pooled mean data of Chhattisgarh plain against different insecticide periods after release during 2009&2010

Table 1. Resistance ratio of R and D-BPH population against different insecticides and periods after release during 2009 and 2010

Treatment	2009						2010					
	RR_R			RR_D			RR_R			RR_D		
	24h	48h	72h	24h	48h	72h	24h	48h	72h	24h	48h	72h
T_1: Imidacloprid	0.44	0.41	0.58	0.44	0.59	0.63	0.47	0.56	0.55	0.21	0.28	0.45
T_2: Fipronil	0.94	1.00	1.00	0.96	1.00	1.00	0.86	0.96	1.00	0.96	0.96	0.98
T_3: Cypermethrin	0.26	0.29	0.36	0.72	0.80	0.82	0.15	0.26	0.30	0.77	0.84	0.88
T_4: Carbaryl	0.96	0.98	0.98	0.51	0.66	0.72	0.94	0.98	1.00	0.64	0.74	0.80
T_5: Buprofezin	0.22	0.24	0.32	0.04	0.32	0.46	0.33	0.32	0.39	0.04	0.36	0.42
T_6: Chlor + Cyper	1.00	0.96	0.96	0.71	0.85	0.92	0.91	0.88	0.96	0.63	0.74	0.90

***R**= Raipur District, **D**= Dhamtari District, **h**=hours
***RR_R**=resistance ratio of Raipur, **RR_D**=resistance ratio of Dhamtari
*Data based on five times replicated in each treatment, twenty BPH nymph released on each treatment

Table 2. Mean data of resistance ratio of R and D-BPH population against different insecticides periods after release during 2009 and 2010

Treatments	RR_R				RR_D			
	24h	48h	72h	Pooled mean	24h	48h	72h	Pooled mean
T_1: Imidacloprid	0.46	0.49	0.57	**0.50**	0.33	0.44	0.54	**0.43**
T_2: Fipronil	0.90	0.98	1.00	**0.96**	0.96	0.98	0.99	**0.98**
T_3: Cypermethrin	0.21	0.28	0.33	**0.27**	0.75	0.82	0.85	**0.81**
T_4: Carbaryl	0.95	0.98	0.99	**0.97**	0.58	0.70	0.76	**0.68**
T_5: Buprofezin	0.28	0.28	0.36	**0.30**	0.04	0.34	0.44	**0.27**
T_6: Chlor + Cyper	0.96	0.92	0.96	**0.95**	0.67	0.80	0.91	**0.79**

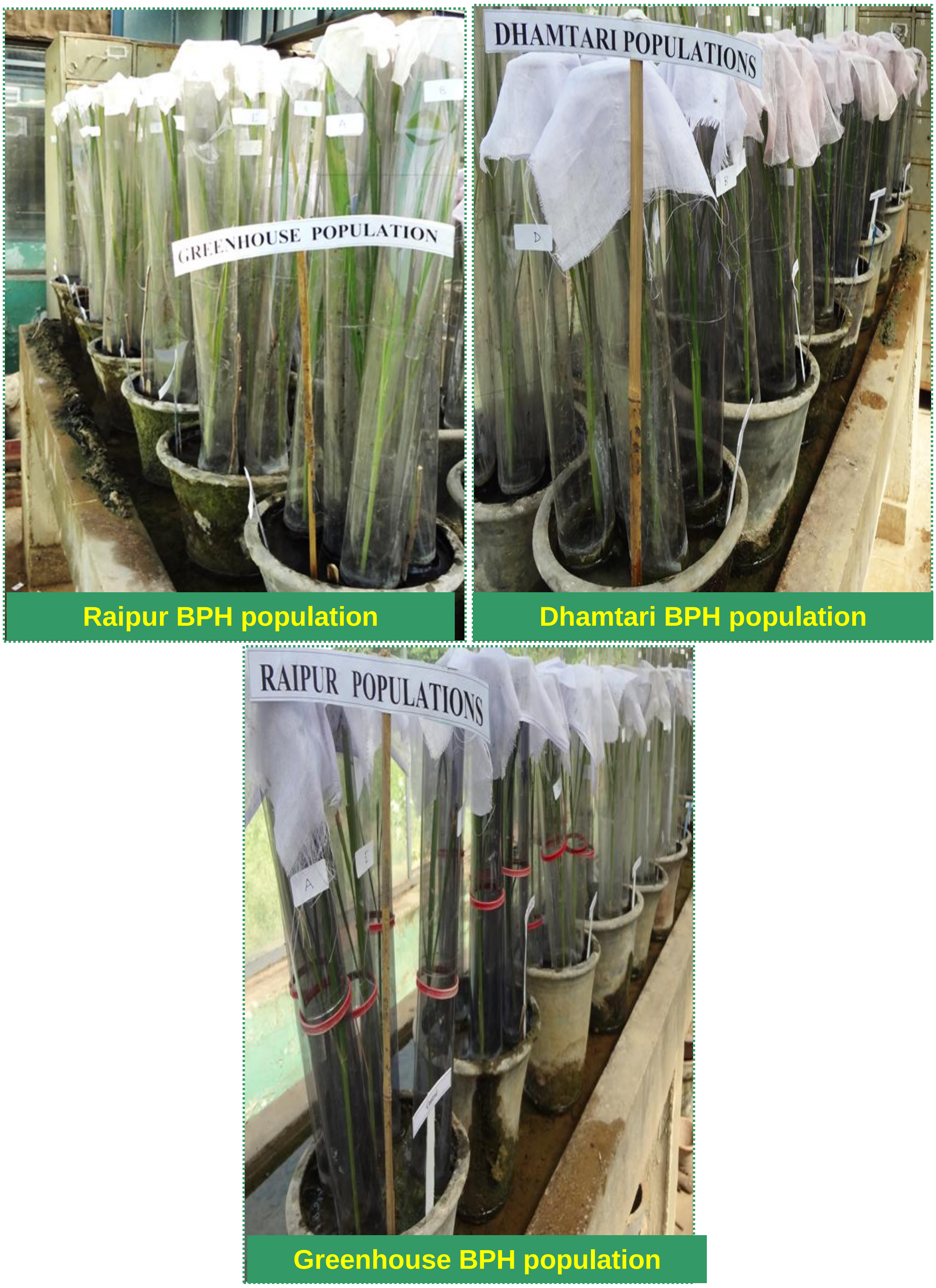

Plate 1. Testing of bioefficacy on fields and glass house of BPH population

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