

Zero tillage and incidence of stem borers under Rice-Wheat Cropping System

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Recently Dr. Ijaz Parvez, NARC, Pakistan has expressed his concern regarding the increased incidence of stem borer in wheat under rice-wheat cropping system (RWCS) to Dr.R.K.Gupta Facilitator, Rice Wheat Consortium. Dr. Gupta has kindly communicated this issue via e-mail message. I am giving my observations in brief.

Stem borers of rice and wheat :

Important species of stem borers causing damage to rice plants in India are (i) Yellow stem borer, YSB (*Scirpophaga incertulas*), (ii) Asian rice borer, ARB (*Chilo suppressalis*), and (iii) Pink rice borer, PRB (*Sesamia inferens*). The YSB is monophagous. Only one additional host, viz., *Leptochloa panicoides*, is reported. The ARB has the ability to migrate to the stems of various grasses in the absence of rice plants. The PRB is polyphagous and in hills of Uttar Pradesh state of India it is considered as an important pest of rice. By virtue of host range limitation, only PRB has the potential to attack wheat crop and it is a well-established pest of wheat crop. One reason of increased incidence of these pests is the carry over of larvae from rice to wheat. These pests are active during March-November. In December larva undergoes induced facultative diapause in the basal node of rice stubble inside the stem below the soil surface just above the root surface. In February when soil temperature rise above 18 C the diapause larva pupates and subsequently gives rise to moth. In the absence of rice plants it could be suicidal generation as should have been the case in most parts of north India where kharif season is followed by rabi. But because of green revolution effect and availability of cheap irrigation water, early transplanted rice crop has become more profitable and also summer rice. The moths of these borers are strong fliers, and aided by wind, may cover three miles or so in a single flight and thus have little difficulty in locating the early rice nursery and summer crop. Use of high nitrogen doses, closer spacing, indiscriminate use of pesticides thus killing natural enemies, lack of importance to select resistant varieties, possible depletion of silica from soil, heaping of rice straw on the corner of plots, lack of follow up of practice to destroy diapause larvae in stubble and straw, etc. are some other important factors which are responsible for the increased infestation of these pests particularly from early 1980s. In case of PRB wheat is the host under RWCS for the continuity of its generations.

Management strategies of PRB in wheat :

Some important options are (i) checking the populations build up of this pest right in the rice crop, (ii) host resistant and (iii) sowing of wheat in a period that help in minimizing the incidence. Regarding the first option, apart from use of biocontrol agents and botanicals, selection of proper pesticide is most important. According to a report lindane is not effective against PRB. Resistance strategy must include both on genetic resistance and nutrient induced resistance. Resistant variety like IR-198007-21 has been shown to release antibiotic chemicals which reduces build-up of population of stem borers while susceptible variety basmati-370 did not have this quality (Marwat,N.K. 1992. Indian Journal Entomology 54(1): 84-88). Role of potassium and chlorine in imparting resistance is well documented. Culm strength of rice plants was increased with improved potassium nutrition. Optimizing the dose of nitrogen in relation with other macronutrients is extremely essential as high nitrogen makes tissues vulnerable to pest and disease attack. Under National Demonstration Project, Rampur (1985-92) good success was obtained in reducing the doses of fertilizers under rice-wheat sequence with promising yield target (Vide paper 8). Foliar- fertilizer therapy has now emerged as a concept in Integrated Pest Management (IPM) (Reuveni,R. and Reuveni,M. 1998. Crop Protection 17(2): 111-118).

Pioneer work of Dr. Y.L.Nene (1966. Bull. Indian Phytopathol. Soc. 3: 97-101) has established zinc requirement for optimum yield of rice and has rejuvenated rice cultivation in many parts of northern India. Now zinc application has been shown to impart resistance against insect pests of rice (Padhee, A.K. and Mishra D.S. 1993. Indian Journal Entomology 55(3): 335-336). Zinc deficiency has now become an important productivity barrier in many crops including wheat. In the current demonstrations of bed planting conducted in village Kallugarhi (Jointly by RWC and KVK) we have sprayed on the stunted wheat crop zinc sulphate +slaked lime and got remarkable recovery.

Silicon that is considered as an essential element for the growth of both rice and wheat has been shown to play an important role in imparting resistance against hoppers (Mishra N.C. and Mishra B.C.1992. Indian Journal Entomology 54(2): 190-195) and other pests. Attempts are needed to develop practice of fertilizer application of silica (e.g. calcium silicate slag). Regarding sowing period, studies conducted at Pantnagar have shown that under timely sown conditions (Nov. 10 to 25) infestation of this borer was recorded only in February. But in late sown conditions (after December 10) infestation was recorded up to April. Interestingly, incidence of shoot fly (*Atherigona naqvii*) on wheat was least when sown during timely regime; timely sowing is a standard recommendation for the control of this pest.

Organic matter management, water management and topsoil conservation are essential pre-requisite for any crop production and protection strategy. Our KVK has been giving necessary feedback in this direction (Vide list of three circulars given below). Other practices which would minimize incidence of pest and diseases are, capitalizing the fungicidal properties of herbicides (I have observed some remarkable antifungal effect of herbicides on soil borne pathogen in my Ph.D. work.), introduction of ecofallows, developing varieties with thinner upright canopy of leaves which allow greater interception of sunlight by the plants which would render microenvironment unfavorable for the soil borne plant pathogens, etc.

Zero tillage under RWCS

The practices of zero tillage and bed planting have been gaining momentum in RWCS. Rice-Wheat Consortium (RWC), in collaboration with our Krishi Vigyan Kendra (KVK) has organized large-scale demonstrations on farmers' fields on zero tillage and bed-planting technologies in rice and wheat. Performance of these demonstrations are so nice that Director General of CIMMYT and Director General of IRRI visited these demonstrations on Feb. 19. Now Noble Laureate Professor Dr.Norman Borlaug will visit these demonstrations on March 12, and address the farmers.

Zero tillage under RWCS and its effect on stem borers:

Practice of zero tillage helps in catching the time. Studies conducted at Pantnagar have shown that under timely sown conditions (Nov. 10 to 25) infestation of this borer was recorded only in February. But in late sown conditions (>December 10) infestation was recorded up to April. Interestingly incidence of shoot fly (*Atherigona naqvii*) on wheat was least when sown during timely regime; timely sowing is a standard recommendation for the control of this pest.

Thus zero tillage technology has great potential in checking the incidence of these pests.

Further zero tillage helps in improving soil health by maintaining organic matter. As a result deficiency of micronutrients will also be mitigated and ultimately plant health will be strengthened. Currently, most of straws under RWCS is burned and wasted. This could have very adverse effect of silicon status soil. Rice cultivars IR 8 yielding 6.9 t rough rice and 6.2 t straw per ha removes 499 kg Si from straw and 81 kg from grain (Vide paper no 9 for this concern). A positive linear relation between straw silicon concentration and rice yields has also been reported (Anderson et al., 1987. *Phytopathology* 79:531-535; Snyder et al., 1986. *Soil.Sci.Soc. Am.J.*50: 1259-1263). With the stubble conservation under zero tillage, this precious element will be conserved and plant will have optimum level of silicon to fight with the stem borers, other external enemies and to maintain its physiological balance for optimum yield.

By virtue of its input of stubble conservation, zero tillage could provide good environment for diapause larvae to survive. Such stubbles have also been shown to have a very favorable effect on the outbreak of some bacterial and fungal diseases (Boosalis, M.G., Doupnik, B and Odvody, G.N. *CRC Handbook of Pest management in Agriculture*). However, such environment could also be congenial for parasites and predators of plant pathogen and pests including stem borers. Rhizosphere population can be manipulated to check plant pathogens (Rovira, 1969) . Good control of soil borne pathogen under conservation tillage has been obtained by following specific fertilization program (Huber, D.M. 1972. *Phytopathology* 62: 434). Attempts are needed to identify such beneficial effects and capitalize for the benefit of farmers. Dent (1991-Dent, D. *Insect Pest Management*, CAB, International) has emphasized that tillage practices can affect crop growth as well as levels of pest infestation so it would be logical to study these effects in tandem. Thus attempts are needed to monitor the population of both pest and parasites for developing the precautionary programme based on soil temperature, humidity, periodicity of occurrence of pests and pathogens and their natural enemies, and other related factors.

A cost effective IPM strategy :

At this juncture I may point out that as a result of surveillance and productive interaction with the farmers of district Saharanpur under NDP (1972-75), I formulated a cost effective and district specific Integrated Schedule of Plant Protection Operations of Rice Crops (Vide paper no.8 below), which helped in saving the crop with minimum use of pesticides. I have been successfully following this approach in different crops all through these years. The papers published from work in district Saharanpur were one of the pioneers in (i) focusing the misuse of pesticides (paper no 1-5 & 7), identifying natural biological control on farmers' fields amid massive application of pesticides (Paper no 7) and integration of pest and disease management strategies in crop production system (Paper no. 8). It was an initial step for IPM under diversified farming system of which RWCS was an important component.

Background papers:

1. Srivastava, S.K. 1970. Pesticide contamination, the problems for developing countries. *PANS* 6(2):266-270.
2. Srivastava, S.K. 1970. Organochlorine pesticide pollution peril. *Farmers' and Parliament* 7(3):11-13 & 29.
3. Srivastava, S.K. 1970. Organochlorine pesticide pollution peril. (Hindi version). *Kisan Bharti* 2(1): 9-14
4. Srivastava, S.K. 1971. Avoid indiscriminate use of agrochemicals. *Farmers' and Parliament* 6(3): 11-12.
5. Srivastava, S.K. 1972. Prospects of pesticides in Indian agriculture. *Pesticides (Annual issue)* 6(12):66-68.
6. Srivastava, S.K. 1972. Fighting insect pests of high yielding paddy cultivars. *Farmers' and Parliament* 7(3): 11-13 & 29.