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Quantifying the role of natural biological control in rice – a case study in a farmer's field

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ABSTRACT: **An On-farm trial was carried out to quantify the natural enemy incidence and its impact on pest incidence on BPT-5204 variety of rice in a farmer's field with and without insecticidal applications, during *kharif* seasons of 1995 and 1996. The results revealed that need based protection involving single insecticidal application and schedule based protection involving three applications of insecticides were superior to natural biocontrol involving no insecticidal application throughout the crop season, in checking pest incidence. However, higher net returns can be obtained by resorting to need based application of insecticides which also results in maintenance of pest population at low levels and build up of natural enemy populations supporting natural control.**

KEY WORDS: Natural biological control, rice

Naturally occurring biological control has a potential role to play in management of rice pests in rice fields of tropical south and southeast Asia and there is a need to emphasize the impact of indigenous natural enemies as an essential part of IPM programmes (Way and Heong, 1994; Ooi and Shephard, 1994). In India, there is sufficient evidence to justify the vital role of natural enemies in suppressing the pest populations in rice (Chelliah *et al.*, 1989; Rao *et al.*, 1983). However, use of *Trichogramma* spp., the only biocontrol agent presently available in rice, was not found adequately beneficial (Pathak *et al.*, 1996). Conservation of the natural enemy fauna *in situ* for suppressing the pest populations seems a good alternative. Farmers continue to resort to insecticidal use for checking pest incidence in their fields without being aware of either the natural biocontrol taking place or impact of these chemicals on the natural bioagents. The quantification of the actual impact of natural biocontrol is essential to convince the farmers of its importance. There are very few reports on quantification of the actual impact of natural biocontrol in rice ecosystems (Beevi *et al.*, 2000).

The present paper reports the efforts made to quantify pest and natural enemy incidence with and without insecticidal applications in a farmer's field at Medchal, 40 kms away from Hyderabad, Andhara Pradesh.

MATERIALS AND METHODS

The on farm trial was conducted during *Kharif* seasons of 1995 and 1996 with BPT 5204, a pest susceptible but popular cultivar. The trial comprised three treatments *viz.*, i. natural biocontrol (NBC) - with no insecticidal application throughout the crop season, ii. need based protection (NBP) - judged by periodic monitoring of pest populations and locally recommended economic thresholds and iii. schedule based

protection (SBP) - involving application of insecticides based on a schedule commonly adopted by farmers. In the present trial, NBP treatment consisted of a single need based application of carbofuran 3G @ 1.0 kg a.i./ha 55 days after transplanting (DAT), while SBP treatment had two applications of carbofuran 3G @ 1.0 kg a.i./ha at 15 and 55 DAT followed by one spray with monocrotophos @ 500 g a.i./ha at 75 DAT. Each treatment covered an area of 1000 sq. m. sub-divided into six equal sub-plots to serve as replications. All the other agronomic practices were common to the three treatments and as per the recommended package of practices.

Observations were recorded on pest infestation on 5 randomly selected hills in 5 fixed quadrates of one sq. m in each of the sub-plots, at weekly interval. The per cent deadhearts/white ears due to yellow stem borer (YSB) and silver shoots due to gall midge were calculated by taking counts of total tillers and number of damaged tillers. Populations per 25 hills were recorded in case of brown planthoppers (BPH) and white backed planthoppers (WBPH). Yield per hectare was computed from crop cuts of 5x5m area recorded per sub-plot. The data were subjected to analysis of variance after suitable transformation. Finally, net returns per additional rupee invested were worked out based on the purchase price of paddy and cost involved in insecticidal applications. Observations were also recorded on natural enemy populations in the three treatments. In YSB, egg masses were collected in each sub-plot for estimation of combined egg parasitism of YSB due to *Tetrastichus schoenobius* Ferriere, *Telenomus dignus Gahan and Trichogramma japonicum* Ashmead, while parasitism due to *Platygaster oryzae* Cameron in gall midge was estimated based on total number of galls and number of parasitized galls. Populations of common predators like spiders (combined population mainly belonging to three genera, *Pardosa, Tetragnatha and Oxyopes*), mirid bugs (*Cyrtorhinus lividipennis* Reuter), coccinellids and staphylinids were made based on visual counts per 25 hills in each sub-plot, while net sweeps (5 double sweep nets per sub- plot every fortnight) were used to record catches of damselflies and dragonflies.

RESULTS AND DISCUSSION

Pest and natural enemy incidence

Gall midge

The incidence of gall midge ranged from 4.1 to 21.5 per cent silver shoots at 55 and 75 DAT, among the three treatments during 1995 (Table 1). There were significant differences among the three treatments, NBP recording lowest damage of 4.1 and 11.2 per cent SS at 55 and 75 DAT, respectively followed by SBP which was on par showing 5.3 and 15.2 per cent SS. Both the treatments were superior to NBC, which showed 12.7 and 21.5 per cent SS, respectively. In 1996, there were no significant differences among the treatments due to low pest incidence (< 5 per cent SS). Egg-larval parasitism of gall midge due to *P. oryzae* was negligible (<5 per cent) in both the seasons.

Yellow Stem Borer

The stem borer incidence ranged from 1.3 to 5.3 per cent dead hearts (DH) among the three treatments during vegetative stage and 0.6 to 3.9 per cent white ears (WE) at harvest in 1995, while in 1996, it varied from 2.2 to 4.4 per cent DH and 1.2 to 4.1per cent WE. Despite low pest incidence, NBP and SBP treatments were statistically superior to NBC.

However, parasitism of stem borer egg masses was observed to an extent of 86.3 per cent in NBC and was significantly higher than that of NBP (49.5%) and SBP (40.5%) at 55 DAT, in 1995 (Fig.1).

Planthoppers

Although, planthoppers are not commonly observed in this region, BPH populations ranging from 22.5 to 39.2 per 25 hills and WBPH counts of 10.0 to 19.6 per 25 hills, were recorded at 80 DAT in 1995. Due to higher levels of predatory spiders and mirid bugs their incidence was significantly lower in NBC plots compared to that

Table 1. Pest incidence, grain yield and economics of different treatments

Treatment	Gall midge (% SS) 1995		Yield (t/ha)		Increase in yield over NBC (t/ha)		Return per additional rupee investment (Rs)	
	55 DAT	75 DAT	1995	1996	1995	1996	1995	1996
Natural bio-control (NBC)	12.7a	21.5a	5.2b	7.0b	-	-	-	-
Need based protection (NBP)	4.1b	11.2b	5.8a	8.0a	0.6	1.0	1.65	2.75
Schedule based protection (SBP)	5.3b	15.2b	6.0a	8.0a	0.8	1.0	-	1.25

of NBP and SBP (Fig. 2).

It was also evident that among the predators, spiders were predominant in both the years (Fig. 3). Their population levels were significantly higher in NBC plot ranging from 2.6 to 13.6 per 25 hills in 1995 and 8.4 to 18.6 per 25 hills in 1996, during 30 to 70 DAT. The NBP treatments showed 1.8 to 9.8 per 25 hills in 1995 and 6.6 to 16.8 per 25 hills in 1996, while SBP recorded 2.3 to 7.8 per 25 hills in 1995 and 6.4 to 13.6 per 25 hills in 1996.

Mirid bugs were observed only at later stage, NBC treatment again showing higher levels of 3.2 and 11.4 per 25 hills at 70 and 80 DAT, respectively compared to 2.4 and 7.2 per 25 hills, in NBP, while SBP treatment showed significantly low populations of 0 and 1.2 mirid bugs per 25 hills, respectively in 1995. In 1996, NBC recorded 8.2 and 11.4 mirid bugs per 25 hills at 70 and 80 DAT, respectively significantly higher than 9.4 and 10.0 per 25 hills in NBP and 0 and 9 per 25 hills in SBP.

Stray populations of other predators like coccinellids, staphylinids, damselflies and dragonflies were also observed, but no clear trends were discernible due to low populations.

Grain Yield and Economics

Data on grain yield revealed that SBP treatment resulted in yields of 6.0 and 8.0 t/ha compared to 5.8 and 8.0 t/ha in NBP and 5.2 and 7.0 t/ha in NBC (Table 1). The NBP treatment resulted in significant increase of 0.6 and 1.0 t/ha over NBC, and on par with that of SBP (0.8 and 1.0 t/ha). Economics of grain yield revealed that need based protection fetched Rs. 1.65 to 2.75 per every additional rupee investment, significantly superior to that of SBP (Rs 1.25).

The results of the study indicate that both need-based protection and scheduled-based protection were clearly superior over natural biocontrol treatment in checking the pest incidence. Similar observations were made by Korat *et al.* (1997). However, highest levels of natural enemy populations were observed in NBC which was the best followed by NBP and SBP. Ambika Devi *et al.* 1998 also reported moderate level of stem borer and gall midge incidence coupled with high egg parasitism of stem borer and predator fauna in natural biocontrol plots. Results also show that higher net returns can be

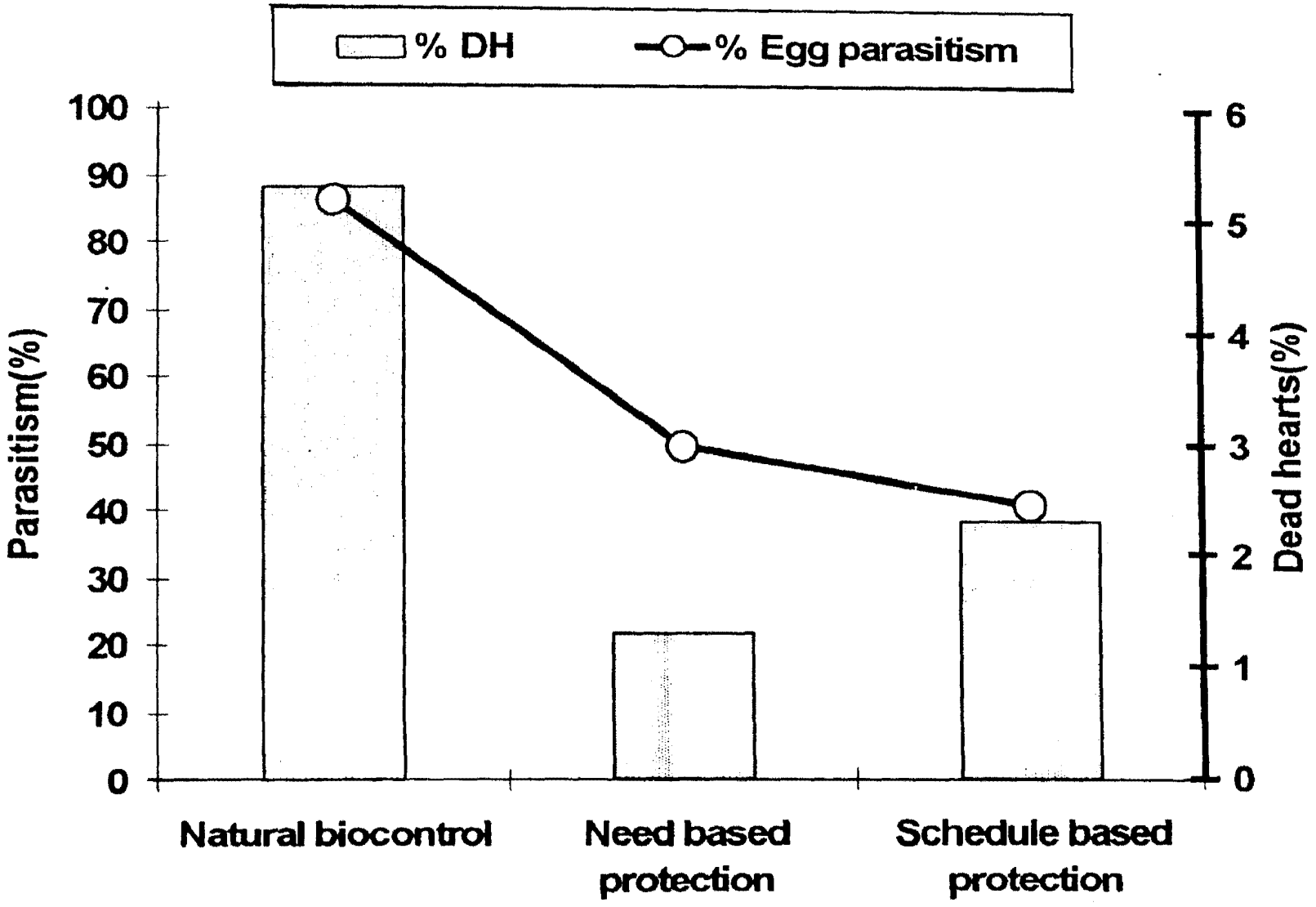

Fig. 1. Incidence and egg mass parastitism of yellow stem borer, Kharif 1995(55 DAT)

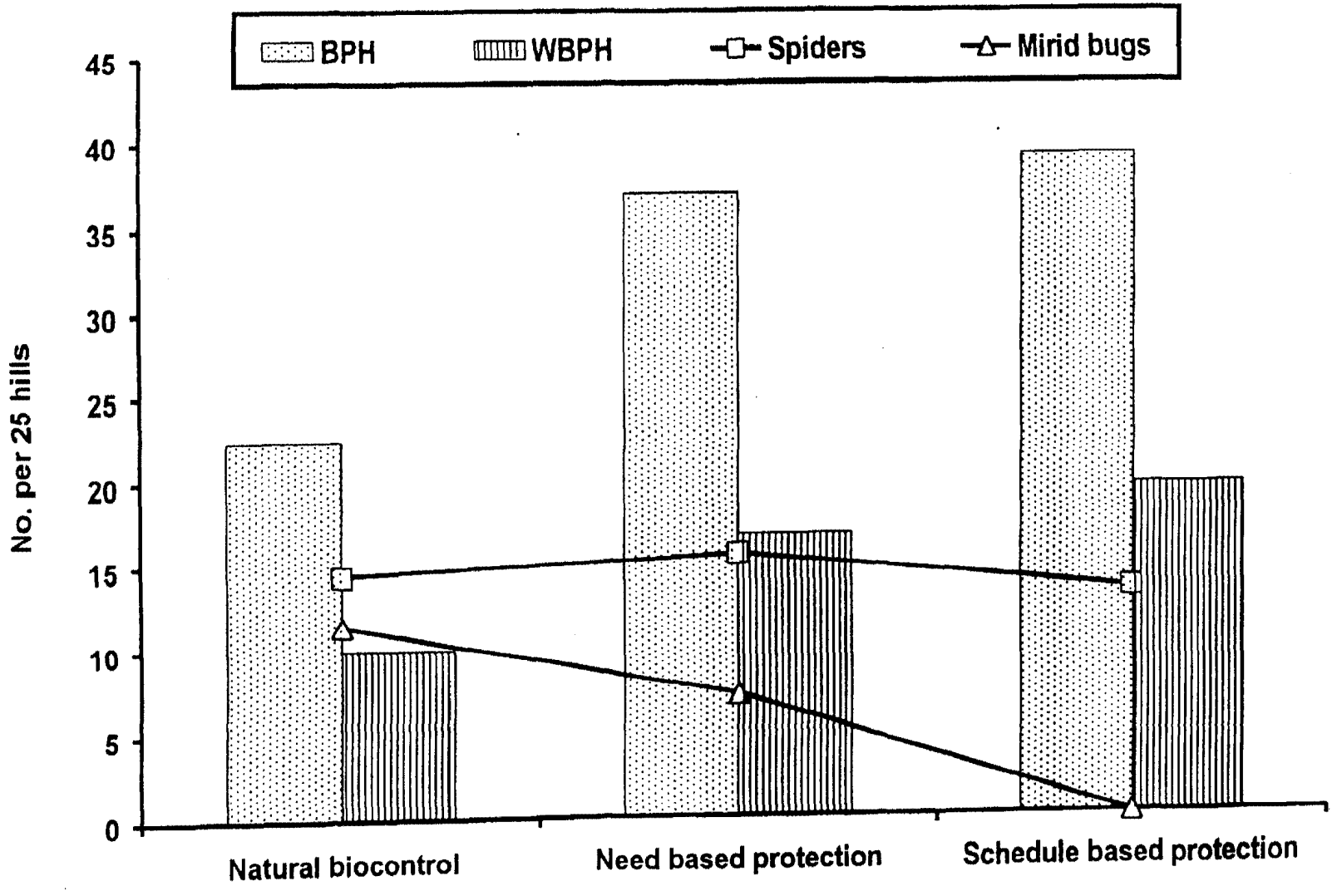

Fig. 2. Incidence of BPH and WBPH and their predators, Kharif 1995(80 DAT)

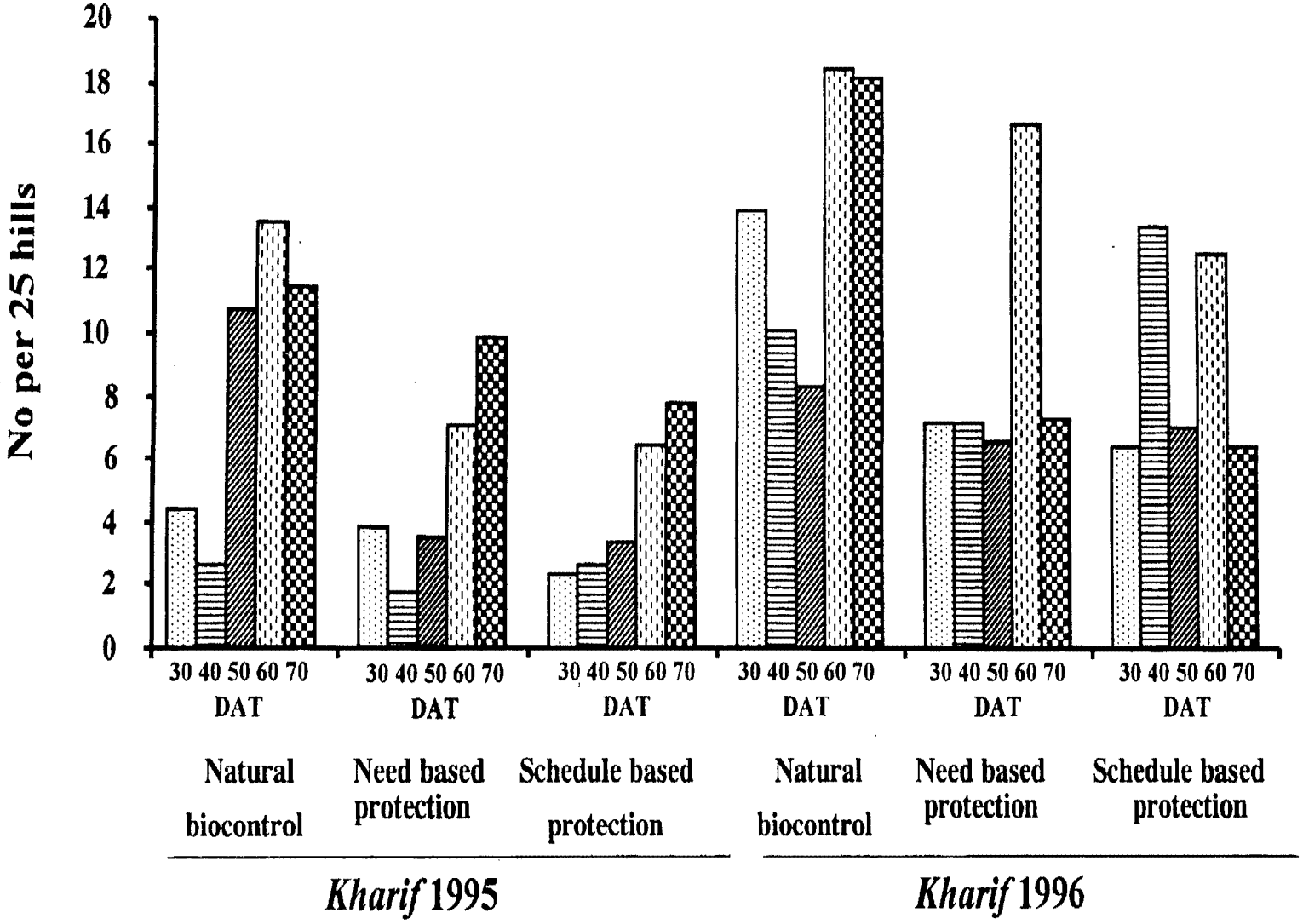

Fig. 3. Natural incidence of predatory spider populations

obtained by resorting to a single need based application of insecticides instead of calendar schedule involving three applications (two granular applications followed by one spray) which also results in maintenance of a pest population at very low levels and build-up of natural enemy populations resulting in natural control. Thus, quantifying natural biocontrol in different agro-ecosystems of rice and demonstrating the effectiveness of natural enemies can help in curbing insecticide use.

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