THE EFFECTIVENESS OF THE ECONOMIC THRESHOLD AS A BASIS FOR INSECTICIDE SPRAY DECISION IN SOYBEAN PEST MANAGEMENT

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ABSTRACT

This research was aimed to reduce the frequency of chemical insecticide use in soybean plantation by applying economic threshold in pest management. Research was conducted at Tongas-Probolinggo during the period of July-November 2007, using randomized block design, three treatments and four replicates. Treatments examined were three different pest control methods, i.e. P1 (without control measure), P2 (weekly recommended insecticide sprayed), and P3 (application of insecticide based on an economic threshold level of each insect pest). Result of research indicated that compared to untreated plot, application of insecticide based on an economic threshold significantly reduced the frequency of insecticide used or reduced of insecticide by 54%, and maintain crop yield 68%, gross income Rp. 9,016,000/ha/season, net income Rp. 8,147,000/ha/season and net profit Rp. 67,890/day. Other advantage which cannot be valued financially is health of environment because the existence of natural enemies, parasitoid and predator, more well secure. As a conclusion, the use of economic threshold is efficient and effective on soybean integrated pest at paddy field applying planting at a time and cropping pattern rice-soybean-soybean.

Key words: economic threshold, natural enemy, pest, soybean, IPM

ABSTRAK

Tujuan penelitian adalah untuk mengurangi frekuensi penggunaan insektisida kimia pada budidaya kedelai dengan menerapkan nilai ambang ekonomi sebagai dasar pengambilan keputusan tindakan pengendalian hama. Penelitian dilakukan di Kecamatan Tongas, Kabupaten Probolinggo pada Juli-November 2007. Penelitian menggunakan rancangan acak kelompok, tiga perlakuan dan empat ulangan. Perlakuan yang diuji adalah tiga tindakan pengendalian hama, yaitu P_1 (tanpa tindakan pengendalian), P_2 (proteksi penuh dengan cara mengaplikasikan insektisida setiap minggu), dan P_3 (aplikasi insektisida berdasarkan nilai ambang ekonomi hama). Hasil penelitian menunjukkan bahwa dibandingkan dengan tanpa tindakan pengendalian, aplikasi insektisida berdasarkan nilai ambang ekonomi nyata mengurangi frekuensi aplikasi insektisida sebanyak enam kali atau mengurangi penggunaan insektisida hingga 54%, mampu mempertahankan hasil panen 68%, penghasilan kotor *(gross income)* Rp9.016.000/musim, penghasilan bersih (*net income*) Rp8.147.000 dan memperoleh keuntungan bersih (*net profit*) Rp67.890/hari. Keuntungan lain yang tidak dapat disetarakan secara finasial adalah kesehatan lingkungan karena keberadaan musuh alami, parasitoid dan predator lebih terjamin. Kesimpulan yang diperoleh adalah penerapan ambang ekonomi hama efektif dan efisien pada pengendalian hama terpadu kedelai di lahan sawah yang menerapkan pola tanam serentak dan pola pergiliran tanaman padi-kedelai-kedelai.

Kata kunci: ambang ekonomi, hama, kedelai, musuh alami, PHT

INTRODUCTION

Among several legumes that grown in a variety of cropping systems, soybean (*Glycines max* (L.) Merr) is very important in Indonesia. The on-farm yield of soybean in Indonesia is much lower than the potential yield of the soybean released variety. One of the major reasons for low yield is the infestation by diverse insect pests from germination to harvest and some even in storage (Tengkano & Soehardjan 1985; Shepard *et al*. 1997; Baliadi *et al*. 2008b). More than 60 species of insect pests are known to affect the soybean in Indonesia (Okada *et al*. 1988), of which about 16 are economically important and limit the soybean production (Noch *et al*. 1983; Shepard *et al*. 1997; Tengkano & Soehardjan 1993; Tengkano *et al*. 1990, 2006a, 2006b). Control of these pests is essential because infestation by certain species, such as *Spodoptera litura, Bemisia tabaci, Riptortus linearis, Helicoverpa armigera* and *Etiella zinckenella* can result in total crop loss (Baliadi & Tengkano 2008; Baliadi *et al*. 2008a,b).

To increase and sustain soybean production, greater effort must be made. Under present farming systems, insecticide application would be considered the most practical means to control the insect pest population (Shepard *et al*. 1997; Baliadi *et al*. 2007; Tengkano *et al*. 2007). They are easy to apply and immediate profits are often substantial. So in modern agriculture, pesticides cannot be ignored (Norris *et al.* 2003). In some cases timely application is frequently lost because of shortage of labor. It should be noted, however that increasing pesticide use means increasing input costs. Frequent applications have resulted in resistance of insects to insecticides, rendering these chemicals ineffectiveness (Hardy 1996). More importantly, increasing pesticide use increases the danger and affects the environment equilibrium by resurgence of pests and by destroying natural enemies (Wilson 1990; Norris *et al*. 2003; Baliadi *et al*. 2008b). Furthermore there are occasions in which insignificant species have attained major pest status after intensive use of persistent insecticides. The question therefore is, how insecticides can be applied or integrated with other methods while keeping the unwanted side effects to a minimum.

Pest population assessment and decision making is among the most basic elements in any integrated pest management (IPM) program (Rauf 1992; Turnipseed & Kogan 1994; Pedigo & Hugley 1992; Pedigo 1996; Kogan 1997; Arifin & Tengkano 2008). More efficient use of insecticide is through the implementation of IPM method (Oka 1995; Shepard *et al*. 1997; Baliadi *et al*. 2008b,c). IPM method involves all possible means to prevent the insect from reaching the economic threshold, at which the inflicted damage exceeds costs of control (Poston *et al*. 1983; Pedigo *et al*. 1986; Willson 1990), so the use of insecticides are basically depending on their economic threshold level (Luckman & Metcalf 1975; Willson 1990; Norris *et al*. 2003).

The study reported here was undertaken to define an efficient and effective of the economic threshold of insect pests in integrated pest management to reduce the frequency and amount of chemical insecticide use.

MATERIALS AND METHODS

The experiment was conducted at Tongas, Probolinggo from July to November 2007. Three treatments (a different pest management method) were arranged in randomized block design and four replicates. The treatments were as follows: P_1= without control measure, P_2 = weekly recommended insecticide sprayed, and P_3 = application of insecticide based on an economic threshold level of each insect pest. The Anjasmoro soybean variety was planted at a plant spacing of 40cm x 10cm, plot size 40m x 12m, two plants/hill. The fertilizer was applied at planting time at the rate of 75 kg N, 100 kg SP36, and 50 kg KCl/ha. Three active ingredients used were sipermetrin, deltametrin and sihalotrin. These insecticides were proved effective against soybean insect pests at Lampung (Baliadi *et al*. 2007; Tengkano *et al*. 2007) and Tongas (Baliadi *et al*. 2008b). The insecticide application decision in P_3 treatment depended on pest economic threshold level (Table 1). Observations on bean fly population were done at six days after

Table 1. Economic threshold of 16 most important soybean pests in Indonesia.

No	Indonesian name	Latin name	Monitoring time (dap)	Stadia of examine	Economic threshold
1	Lalat kacang	*Ophiomyia phaseoli* Tr.	5 , 6	Imago	ET : 2 imago/30 clumps, ≥ 2,5% plant affected
2	Kutu cabuk	*Aphis glycines* Mats	6, 14, 21, 28	Imago and nymph	ET: 200 imago and nymph/10 clumps
3	Kutu kebul	*Bemisia tabaci* Genn.	6, 14, 21, 28		ET: 20 imago and nymph/10 clumps
4	Kumbang Daun kedelai	*Phaedonia inclusa* S tal.	6, 14, 21, 28, 35, 42, 49	Imago, larvae, egg	ET: 1 imago/10 clumps
5	Ulat grayak	*Spodoptera litura* F.	14, 21, 28, 35, 42, 49	Larvae and egg	ET: 2 instar-3/clump or 2 egg groups/100 clumps
6	Ulat jengkal	*Chrysodeixis chalcites* Esp.	14, 21, 28, 35, 42, 49	Larvae	ET: 200 instar-1/10 clumps, 120 instar-2/10 clumps, 20 instar-3/10 clumps, 25% leave damage
7	Ulat jengkal	*Tricoplusia orichalcea* F	14, 21, 28, 35, 42, 49	Larvae	ET: 200 instar-1/10 clumps, 120 instar-2/10 clumps, 20 instar-3/10 clumps, 25% leave damage
8	Penggulung daun	*Lamprosema indicata* F.	14, 21, 28, 35, 42	Larvae	ET: 30 larvae/10 clumps, 25% leave damage
9	Penggulung daun	*Adoxophyes privatana* Walker	14, 21, 28, 35, 42	Larvae	ET: 30 larvae/10 clumps, 25% leave damage
10	Kepik coklat	*Riptortus linearis* F.	35, 42, 49, 56, 63, 70	Imago and nymph	ET at trap crop: 1 imago/10 clumps or at soybean: 1 imago/ 10 clumps; ≥ 2,5% pod damage
11	Kepik coklat	*Riptortus annulicornis*	35, 42, 49, 56, 63, 70	Imago and nymph	ET at trap crop: 1 imago/10 clumps or at soybean: 1 imago/ 10 clumps; ≥ 2,5% pod damage
12	Kepik hijau	*Nezara viridula* L.	35, 42, 49, 56, 63, 70	Imago and nymph	ET at trap crop: 1 imago/10 clumps or at soybean: 1 imago/ 10 clumps; ≥ 2,5% pod damage
13	Kepik hijau pucat	*Piezodorus hybneri* Gmelin	35, 42, 49, 56, 63, 70	Imago and nymph	ET at trap crop: 1 imago/10 clumps or at soybean: 1 imago/ 10 clumps; ≥ 2,5% pod damage
14	Penggerek polong	*Etiella zinckenella* Tr.	35, 42, 49, 56, 63, 70	Imago, egg and larvae	ET at trap crop: 2 imago/clump, or ≥ 2,5% pod damage and ET at soybean: 2 imago/clump, or ≥ 2,5% pod damage
15	Penggerek polong	*Etiella hobsoni* Butl.	35, 42, 49, 56, 63, 70	Imago, egg and larvae	ET at trap crop: 2 imago/clump, or ≥ 2,5% pod damage and ET at soybean: 2 imago/clump, or ≥ 2,5% pod damage
16	Pemakan polong	*Helicoverpa armigera* Hubner	35, 42, 49, 56, 63,70	Larvae and egg	ET: 15 instar-2/10 clumps, 10 instar-3/10 clumps, or ≥ 2% pod damage

Note: dap = days after planting; ET = economic threshold, clp = clump planting (dap) by examine 50 plants/plot by systemic diagonal random sampling in each plot and control measured was done at 8 dap. Insect pests population were observed weekly at 7, 14, 21, 28, 35 dap for the leaf sucker and at 14, 21, 28, 35, 42, 49 dap for the leaf-feeder. The pod eating, boring and sucking insects were observed weekly during the period 39-70 dap. Number of pods and grain yield were recorded. Besides insect pest population and grain yield, the data of insecticide price, labor wages, amount of insecticide sprayed, and soybean price at harvest time were also observed.

RESULTS AND DISCUSSION

Bean Fly Population

The imago population of *O. phaseoli* at all control measures tested was between 2.2-2.5/30 clumps at 6 dap. This would indicate that soybean crops would be attacked, if no insecticide applied, because the population of insect was higher than its economic threshold (2 imago/30 clumps). At present, only chemical control methods are effective. Sipermetrin insecticide sprayed at 8 dap on P_2 and P_3 plots before the white larva tunnels down a leaf vein into the stem where it feeds and pupates. The population decreased by about 89,3% and 85,7% in the P_2 and P_3 plots than the untreated check plot (P_1) which number of imago was 2.8/30 clumps (Fig. 1).

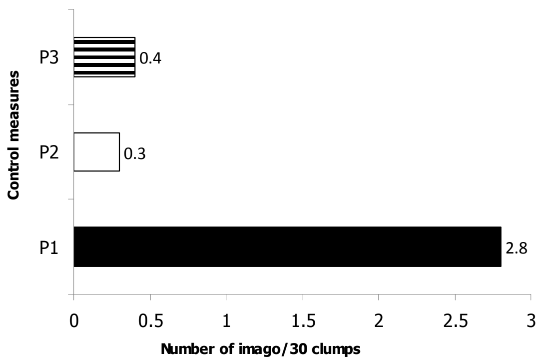

Figure 1. The population of bean fly at 14 dap.

P_1= without control measure, P_2 = weekly recommended insecticide sprayed, and P_3 = application of insecticide based on an economic threshold level of each insect pest. The economic threshold of *O. phaseoli* is 2 imago/30 clumps.

At P_1 insect population and crops damaged by bean fly infestation increased in the later stage of soybean growth. The upper stems of young plants wilted, and the plants may die, but older plants survived with little reduction in pod production. When damage is seen, it is too late to take remedial action. These results revealed that bean fly is major pest in soybean and used of Sipermetrin at the dose of 2 ml/l at 8 dap was effective in controlling bean fly. Close examination of the stem at the base of the wilted portion revealed a larva or puparium of bean fly. The windy environmental during the second dry season might also influence the landing of the bean fly imago from outside experimental plot on the soybean crops, resulted in a higher egg oviposition.

Leaf Sucker Insect Pests Population

Results of the experiment showed that different control measures significantly influenced the population of imago and nymph of leaf sucker insects, *A. glycines* and *B. tabaci*, at 14, 21 and 28 dap (Fig. 2).

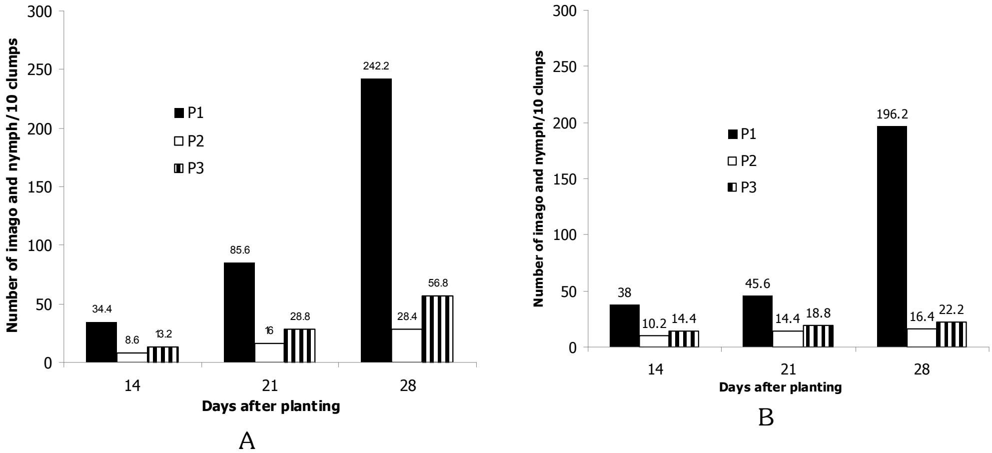

Figure 2. The population of (A) *A. glycines* and (B) *B. tabaci* at 14, 21 and 28 dap.

dap= days after planting. P_1= without control measure, P_2 = weekly recommended insecticide sprayed, and P_3 = application of insecticide based on an economic threshold level of each insect pest. The economic threshold of *A. glycines* and *B. tabaci* is 200 imago and nymph/10 clumps and 20 imago and nymph/10 clumps.

At 14 dap, the population of *A. glycines* decreased by about 75% and 61.6% in the P_2 and P_3 plots than the untreated check plots (P_1) which number of imago and nymph was 34.4/10 clumps (Fig. 2A), while its was 73.1% and 62.1% decreased in the P_2 and P_3 for *B. tabaci* (Fig. 2B). The same results were observed at 21 and 28 dap, in treatment P_2 and P_3 insect pests infestation was significantly lower as compared to untreated check plots (P_1). It appears that Sihalotrin and Deltametrin was adequately control the infestation of leaf sucker insects. Baliadi (2006a,b) and Baliadi *et al.* (2007) found that Deltametrin and Sihalotrin gave an excellent reduction of *A. glycines* and *B. tabaci* adult population and it was considerably lower in all treated plots and can be used if needed. Usefulness of this insecticide can also be judge by examining the virus diseases incidence, such as *soybean mosaic virus* (SMV), *soybean stunt virus* (SSV) and *cowpea mild mottle virus* (CPMMV), because these insects are important as the vector of a virus diseases. The suppression of the first migration of these insects was significantly reduced the virus diseases incidence by lowering the infection rate of virus transmitted. It may also be noted that the two insects constitutes a mobile population in the field due to which treatment effects are not very apparent in nature.

Aphid and whitefly colonies on soybean seldom thrive for long, probably because of the natural enemy activity. Rain also resulted in large reduction in infestation.

Leaf Feeder Insect Pests Population

Results of the experiment showed that different control measures significantly influenced the population of imago and nymph of leaf feeder insects, *S. litura, C. chalcites*, and *L. indicate*, at 14 - 49 dap (Fig. 3). None population of these insects was found at 14 and 21 dap. At 28 dap, the population of *S. litura* decreased by about 61.1% and 33.3% in the P_2 and P_3 plots than the untreated check plot (P_1) which number of instar 3 was 3.6/clump (Fig. 3A), while its was 82.5% and 46% decreased in the P_2 and P_3 for *C. chalcites* (Fig. 3B) and 54.5% and 27.3 decreased in *L. indicata* (Fig. 3C). The same phenomenon was found at 35, 42 and 49 dap observations, in treatment P_2 and P_3 insect pest population was significantly much lower as compared to untreated check plots (P_1). The result confirmed that these insect pests were common on soybean crops. The population of *C. chalcites* and *L. indicata* during the observation period was always below of their economic threshold levels, i.e. 0-5.6 larvae and 0-14.2 larvae/10 clumps at P_2 and P_3 for *C. chalcites*, while 0-6.4 larvae and 0-10.4 larvae/10 clumps at P_2 and P_3 for *L. indicata*. The most common method of control of leaf feeder insect pests is chemical, using insecticide. In many cases, the recommended insecticides are only effective against the first instar, but the effectiveness varied among the second, third and fourth instars (Suharto 1987), which possibly due to improper application such as lethal dosage, volume of water and timing of application, or insect resistance mechanism as well. Our research showed that Deltametrin at the dose of 1 ml/l was effective on *S. litura, C. chacites* and *L. indicata.* Keeping the pest population under its economic threshold levels clearly showed the effectiveness of Deltametrin, excepting at 28 dap insecticide should be sprayed at P_3 because the population of *S. litura* was higher than its economic threshold.

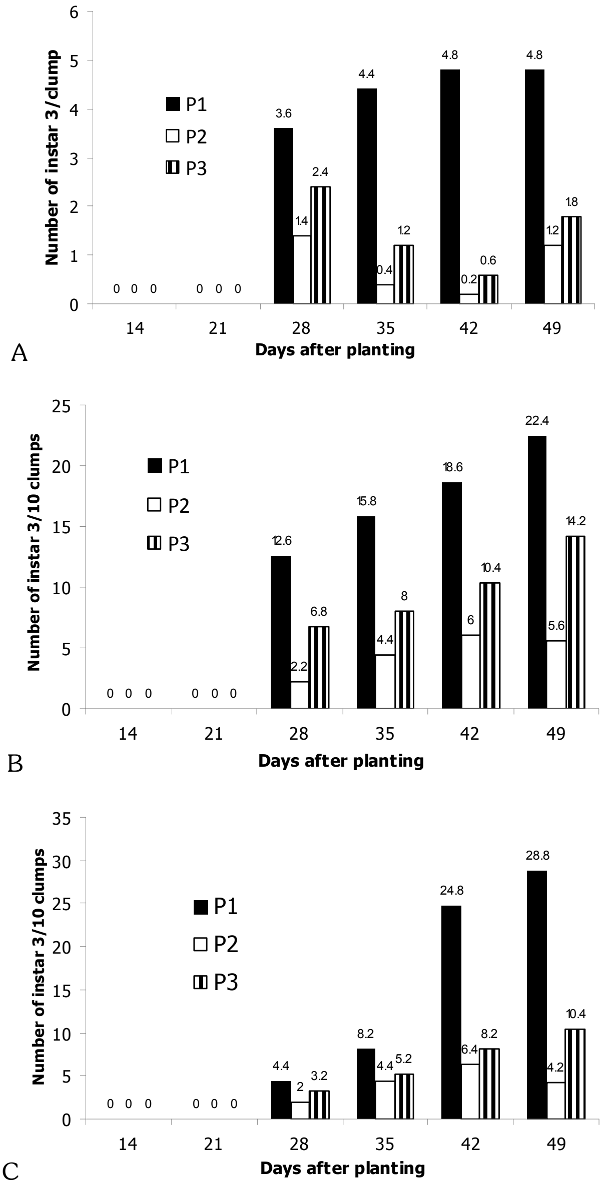

Figure 3. The population of (A) *S. litura*, (B) *C. chalcites*, (C) *L. indicata* at 14–49 dap.

dap= days after planting. P_1= without control measure, P_2 = weekly recommended insecticide sprayed, and P_3 = application of insecticide based on an economic threshold level of each insect pest. The economic threshold of *S. litura*, *C. chalcites*, and *L. indicata* is 2 instar-3/clump, 20 instar-3/10 clumps, and 30 larvae/10 clumps, respectively.

Pod Sucker Insects Population

Results of the experiment showed that different control measures significantly influenced the population of imago and nymph of pod sucker insects, *R. linearis, N. viridula* and *P. hybneri*, at 35-70 dap (Fig. 4). Low or none population of these insects was found at 35 and 42 dap. Fig. 4A showed that *R. linearis* population at control plots started to increase at 49 dap, i.e. reached its peak at 56 dap (2.8 imago/10 clumps), means the population ≥ economic threshold level. Excepting at 56 dap, population of *R. linearis* at P_3 was always lower than economic threshold, so insecticide sprayed took at 56 dap to suppress the *R. linearis* to its below economic threshold. In case of *N. viridula* and *P. hybneri*, their population dynamic did not differ to the *R. linearis* did, but during the research their populations was always under economic threshold levels (Fig. 4B and 4C).

At 49 dap, the population of *R. linearis* decreased by about 66.7% and 63.6% in the P_2 and P_3 plots than the untreated check plot (P_1) which number of imago was 2.2/10 clumps, while its was 91.7% and 66.7% decreased in the P_2 and P_3 for *N. viridula* and 100% and 33.3 decreased in *P. hybneri*. The same phenomenon was found at 35, 42 and 49 dap, in treatment P_2 and P_3 insect pest population was significantly much lower as compared to untreated check plots (P_1). The result confirmed that these insect pests were common on soybean crops. Our result revealed that pod sucker insects started to appear 35 dap and reached their peak at 56 dap. Two others pod sucker insect found at low density were *Plautia affinis* and *Melanacanthus* sp.

Pod Borer and Eater Insects Population

Results of the experiment showed that different control measures significantly influenced the population of imago of pod borer, *E. zinckenella* and pod eater, *H. armigera*, at 35 - 70 dap (Fig. 5A). During research, the second dry season, soybean suffered heavy damage these two insect pests. In untreated check plot (P_1), pod borer imago started to appear about 10 days after flowering and reached its peak at 56 dap (2.8 imago/clump), while at P_3 population started to increase at 42 dap, i.e. reached its peak at 63 dap (2 imago/clump), means the population reached economic threshold level (2 imago/clump). So insecticide sprayed took at 63 dap to suppress the pod borer population into its below economic threshold.

The farmer mentioned that the highest population of pod borer and pod eater usually appears in late of August and first week of September. Most of the farmers in experimental sites do not growing soybean during the period. The result also suggested that *H. armigera* was important pest on soybean. Farmers used to harvest their maize crops on July-August, so the moths of *H. armigera* directly flight and migrate to soybean which sowing in July. In untreated check plots (P_1), pod eater imago started to appear about 5 days after flowering and reached its peak at 49 dap (12.8 instar1-3/10 clumps), while at P_3 population did not reach its economic threshold level (10 instar 1-3/10 clumps) (Fig. 5B). *H. armigera* have many parasitoid and predators.

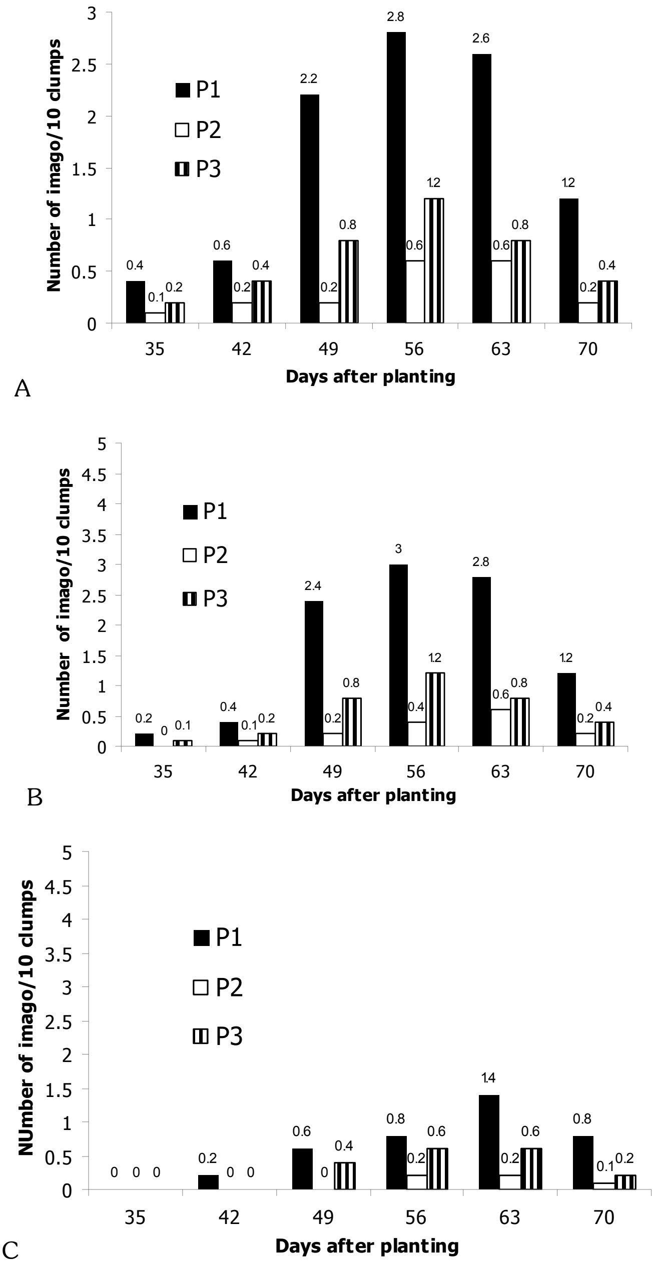

Figure 4. The population of (A) *R. linearis*, (B) *N. viridula*, (C) *P. hybneri* at 35-70 dap.

dap= days after planting. P_1= without control measure, P_2 = weekly recommended insecticide sprayed, and P_3 = application of insecticide based on an economic threshold level of each insect pest. The economic threshold of these insects are 1 imago/10 clumps.

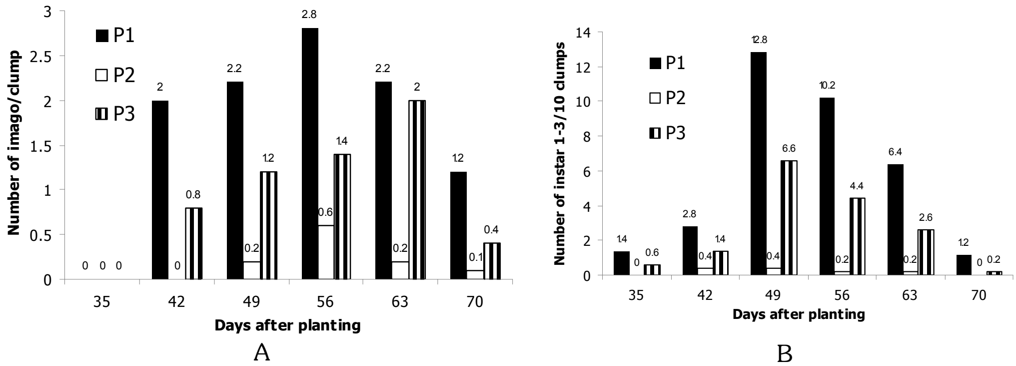

Figure 5. The population of (A) *E. zinckenella* and (B) *H. armigera* at 35 - 70 dap.

dap= days after planting. P_1= without control measure, P_2 = weekly recommended insecticide sprayed, and P_3 = application of insecticide based on an economic threshold level of each insect pest. The economic threshold of *E. zinckenella* is 2 imago/clump and 10 instar 1-3/10 clumps for *H. armigera*.

In the research site some parasitoid like *Heteropelma scaposum, Netelia producta, Lissopimpla* sp., and predator, such as *Coccinella repanda, Harmonia arcuata, Micraspis* sp., *Coranus* sp., *Chrysopa* sp., *Labidura* sp., *Syrphidae, Lycosa* spp., *Oxyopes javanus*, *Salticidae* sp., *Andrallus spinidens,* etc. were found abundantly in untreated check and application of insecticide based on an economic threshold level plots. Three entomopathogens were identified from the experimental site, i.e. Nuclear Polyhedrosis Virus (NPV), *Entomophaga* sp., *Nomuraea rileyi*. These natural enemies suggest give adequate control to soybean insect pests (Carner *et al.* 1997) and unwisely insecticide use may lead to increase in insect pests through reduction of these natural enemies (Rauf 1992; Tengkano et al. 1992; Higley 1994). Turnipseed and Kogan (1994) suggested that a basic system developed primarily for soybean pests management consisted of (1) systematic monitoring during periods of risk to monitor crop growth, crop damage, insect development, and natural enemy activcity, (2) the use of action-decision rules based on economic threshold levels, and (3) the use of minimum rates of insecticides when necessary to reduce pest populations to subeconomic levels with minimal impact on natural enemies.

Soybean Yields

Results showed that weekly recommended insecticide sprayed (P_2) and application of insecticide based on an economic threshold level of each insect pest (P_3) had higher yield significantly over the untreated check plots (Fig. 6). Although the highest yield was 2.15 t/ha, reached by treatment P_2, followed by P_3 i.e. 1.98 t/ha, however it was still lower than the potential yield, 2.5 t/ha.

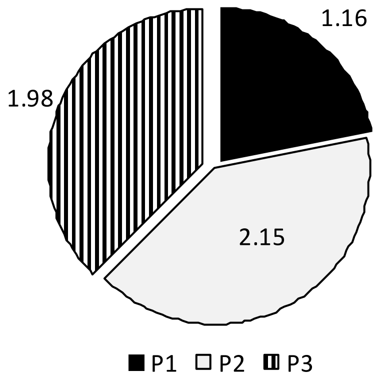

Fig 6. Yields of soybean (t/ha) on three different control measures tested.

P_1= without control measure, P_2 = weekly recommended insecticide sprayed, and
P_3 = application of insecticide based on an economic threshold level of each insect pest.

The less yields in untreated check plot (P_1) was mainly due to very few inputs are devoted to the production, unimproved cultural practices. This situation gave a very poor economic return compared with treatment P_2 and P_3. It is understood P_2 ensured favorable economic, but not for ecological and social consequences which encouraged at P_3. These results offer real advantages for successful soybean production not only in combating pest problem but also in helping many resource poor knowledge soybean farmers in research site. The outcomes of this research were economic threshold and Anjasmoro soybean variety understood and adopted by the neighboring farmers. The harvesting seeds distributed among them to solve the high demand of this variety.

Amount of Insecticide Sprayed

Previously, the use of objective economic threshold has had an important impact on environmental quality, particularly in rice crop where it is the basis for IPM (Oka 1995). The results suggested that application of economic threshold on soybean reduced 54% of insecticide use by decreasing the frequency of application. Indeed, it has been estimated that pest monitoring, establishment of economic threshold, and decreasing the frequency can reduce pesticide use by 45% (Baliadi *et al.* 2008). In the case of pest population below its economic threshold, insecticide spray decision could be postponed until the next week observation. One reason for using the economic threshold in combating an certain soybean insect pests is that soybeans have a great capacity to compensate for damage inflicted by hail and by foliage-feeding insects. Soybean plants can tolerate up to 35 percent defoliation until bloom, about 15 percent while pods are small and soft, and about 35 percent when pods start hardening. Below these levels, defoliation does not adversely affect crop yield, so control is not suggested.

During the experiment only five sprays of insecticide required at P_3 plots for reduced the crop loss, while it was 11 sprays were required for fully protected plot (P_2). Further decreases in insecticide inputs in these situations can and should be attempted by developing environmentally based economic injury level and its concomitant economic threshold. These results also suggested that Sipermetrin, Deltametrin and Sihalotrin insecticide active ingredients are effective and efficient to control the soybean insect pests during their growth and development.

Economic Analysis

As would be expected, the highest gross income was from fully protected plot (P_2), i.e. Rp. 9,890,000/ha/season, but the highest net income (Rp. 8,147,000/ha/season) was attained from P_3 treatment as well as net profit (Rp. 67,892/day) (Table 2). This means that the earliest pest monitoring, wise and trust insecticide spray method based on economic threshold created as increased in net income as well as net profit. The present findings have been corroborated with the findings of Baliadi *et al*. (2008b), that carried out research at the first dry season and findings the highest net income was obtained from the application of insecticide based on an economic threshold (P_3) followed by P_2 and P_1.

Table 2. Yield, gross income, input, net income, net profit and advantage difference compared to untreated check plot in soybean plantation with or no application of insecticide based on an economic threshold.

Treat	Yield (t/ha)	Keeping yield gap (%)	Gross income (Rp/ha)	Input (rp)		Net income (Rp/120 days)	Net profit (rp/day)	Advantage difference compared to P_1
				Labor	Insecticide*			
P1	1.16	-	5,336,000	-	-	5,336,000	44.467	-
P2	2.15	85.3	9,890,000	165,000	1,722,000	8.003,000	66.692	2,667,000
P3	1.96	68.9	9,016,000	75,000	794,000	8,147,000	67.892	2,811,000

Note: labor cost Rp15,000/day; soybean price at harvest time Rp4,600/kg; input = insecticide and labor cost. P_1 (untreated check, without pest control), P_2 (weekly recommended insecticide sprayed), and P_3 (application of insecticide based on an economic threshold). * Data of inputs was taken from Table 3.

Tabel 3. Type and dose of insecticide used and total cost during growth and development of soybean.

Insecticide	Dose		Price per 1000 cc (Rp)	Treatment of pest control (Rp)		
	Litre	ha		P_1	P_2	P_3
1. Sidametrin (sipermetrin)	2 cc/l	1000 cc	80,000	-	80,000 (1)	-
2. Matador 25 EC (sihalotrin)	1 cc/l	500 cc	175,000	-	1050,000 (6)	350,000 (2)
3. Decis 2,5 EC (deltametrin)	1cc/l	500 cc	148,000	-	592,000(4)	444,000 (3)
Total cost needed				-	1,722,000	794,000

Note: (..) number in the bracket was a frequency of insecticide sprayed at each treatment tested. P_1 (untreated check, without pest control), P_2 (weekly recommended insecticide sprayed), and P_3 (application of insecticide based on an economic threshold).

CONCLUSION

Application of insecticide based on an economic threshold reduced the frequency of insecticide sprayed or reduced an insecticide used up to 54%, can maintain crop yield 68%, gross income Rp. 9,016,000/ha/season, net income Rp. 8,147,000/ha/season with net profit Rp. 67,890/day. Other advantage which cannot be valued financially is health of environment because the existence of natural enemy, parasitoid and predator, more well insurance. In addition, the use of economic threshold is efficient and effective on soybean integrated pest at paddy field applying planting at a time and cropping pattern rice-soybean-soybean.

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