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Research Article

AGRO ECOSYSTEM ANALYSIS AND ECOLOGICAL ENGINEERING FOR PEST MANAGEMENT IN PIGEON PEA (*Cajanus cajan* L*)*

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Abstract: Agro Ecosystem Analysis helps to understand the whole system of interactions in agriculture field, the knowledge on Pest and defender population dynamics can be used to reduce the negative impact of pests. After a brief exposure and training, farmers can practice AESA in their own fields. Habitat Manipulation through ecological engineering lowers cultivation costs by encouraging farmers to suppress pests below 2:1 Pest: Defender ratio. EE has great impact in pigeon pea ecosystem to supress the pests and to maintain defender population. Knowledge on defenders and their role in managing insect pests avoids indiscriminate use of chemical pesticides and helps in development of sustainable agriculture ecosystem.

Keywords: Agro Ecosystem Analysis, Ecological Engineering, Pigeon pea, sustainable agriculture

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Introduction

Pulses are important for the nutritional security of the cereal based vegetarian diet of large population. Total pulse area is about 25 mha in India, which produces about 18 m tonnes [l]. Pigeon pea (*Cajanus cajan*) is a tropical grain legume mainly grown in India and ranks second in area and production after chickpea [2]. Pigeon pea is grown in 24 states and 3 union territories in India. In most areas of the country, insects are the most important yield constrains [3]. Management of pests in pigeon pea is complicated as the crop is affected by three different groups of insect with different biology and variable population dynamics. Worldwide over 30 lepidopterans and dipterans feed on pigeon pea and among them pod borer, *Helicoverpa armigera*, spotted pod borer, *Maruca vitrata* and pod fly *Melanagromyza obtusa* are very important insects leading to great losses [4]. Ecological engineering has recently emerged as a paradigm for considering pest management approaches that are based on cultural practices informed by ecological knowledge rather than on high technology approaches such as synthetic pesticides and genetically engineered crops [5]. The aim of ecological engineering in agriculture ecosystem is to integrate soil and pest management strategies with regular practices of farmers for the benefit of environment and farming community. It involves knowledge of agriculture, ecology and farm economics, for restoration and construction of healthy and sustainable agriculture ecosystems [6]. Ecological engineering is the restoration of ecosystems that have been substantially disturbed by human activities; with incorporation of biofertilizers, particularly mycorrhiza which plays an important role in improving soil health and uptake of important macro and micronutrients by the crops [7] Goals of Ecological Engineering are restoration of ecosystems *i.e*., the return of ecosystem to a close approximation of its condition prior to disturbance and development of new sustainable ecosystems that have both human and ecological value. AESA (Agroecosystem Analysis) is an approach, which can be gainfully employed by extension functionaries and farmers to analyse field situations with regard to pests, defenders, soil conditions, plant health, the influence of climatic factors and their interrelationship for growing healthy crop [8]. AESA is holistic approach and a portion of AESA *i.e.* pest and defender interactions over the crop season were considered to conduct the present study.

Materials and Methods

The present study was carried out at NIPHM ecological engineering organic field, Rajendranagar, Hyderabad. The variety used was ICPL-87119 (Asha) collected from ARS, Tandur. The method followed was transplanting method. Seedling are raised in a nursery and transplanted in the field at a spacing of 90X20 cm. The area of the experiment was 0.5 acre. The entire pigeon pea field was surrounded by the ecological engineering plants. Nectar rich plants with small flowers *i.e.* mustard, sunflower, cowpea, sesame, sun hemp etc., are planted to provide shelter and food to the adults of parasitoids and bees. Marigold was maintained as trap crop for *Helicoverpa armigera* eggs and to repel beetles and nematodes. Around the pigeon pea field corn was planted as border crop. No external inputs like chemical fertilizers and pesticides were used in the field. Sustainable ecosystems were developed with natural inputs like green manure, farm yard manure, vermi compost, biofertilizers like Mychorrhyza, phosphate solubilizing bacteria, Potassium mobilizing bacteria and zinc solubilizing bacteria. Bio pesticides like *Trichoderma harzianum* and *Pseudomonas fluroscence* were used for bio priming. Polyphagous pests like *Spodoptera litura* and *Helicoverpa armigera* were monitored using pheromone traps. A total of 10 plants were selected and tagged for recording the observations. Observations of insect pests as well as defenders were taken. Weekly observations were taken through Plant Inspection Method (PIM) starting from four weeks of transplanting to till the pest population was negligible on the crop.

Results

Pigeon pea took 4 weeks for initial establishment and entering into growth phase after transplanting. Data collection initiated 4 WAT and only mites were observed as pest and coccinellids and spiders were observed as defenders. Pest: Defender ratio calculated was 1:2. Mites, leaf eating caterpillars and leaf eating beetles were recorded as pests and spiders as defenders 5 WAT in the field, the P:D ratio was 3:1. P: D ratios were recorded as 1:1, 2:1, 2:1, 2:1, and 1.5:1 on 6, 7, 8, 9 and 10 WAT, respectively. 11 WAT P:D ratio was 2.5:1 where leaf eating beetles, leaf webbers, cow bugs, semi loopers and hairy caterpillars were recorded as pests and coccinellids and spiders as defenders.

Table-1 AESA observations of pests and defenders in Redgram 2017-18 (Date of Transplanting: (21-06-2017), NIPHM, Rajendranagar

Pests	No./Plant	P:D Ratio	Defenders	No./Plant
18-07-2017, 4 WAT observations		1:2		
Mites/ leaf	7.53		Coccinellids	0.20
			Spiders	0.20
25-07-2017, 5 WAT observations		3:1		
Mites	0.9		spiders	0.1
Leaf eating caterpillars	0.4			
Leaf eating beetles	0.1			
02-08-2017, 6 WAT observations		1:1		
Leafhoppers	0.33		Coccinellids	0.3
Cow bugs	0.4		Spiders	0.5
10-08-2017, 7 WAT) observations		2:1		
Leaf eating beetle	4.4		Coccinellids	1
Spittle bug	0.3		Spiders	0.3
Leaf webber	0.5			
Cow bugs	0.5			
16-08-2017 (8 WAT) observations		2:1		
Leaf eating beetles	4.4		Coccinellids	1
Spittle bug	0.3		Spiders	0.3
Leaf webber	0.5			
Cow bugs	0.5			
23-08-2017 (9 WAT) observations		2:1		
Leaf eating beetle	3.2		Coccinellids	0.3
Hairy caterpillar	0.1		Spiders	0.2
Leaf webber	0.2			
Cow bugs	0.7			
30-08-2017 (10 WAT) observations		1.5:1		
Leaf eating beetle	3.4		Coccinellids	0.8
Leaf webber	0.2		Spiders	0.3
Cow bugs	1			
06-09-2017 (11 WAT) observations		2.5:1		
Leaf eating beetle	0.4		Coccinellids	0.6
Leaf webber	0.4		Spiders	0.9
Cow bugs	0.3			
Semi looper	0.1			
Hairy caterpillar	0.1			
26-09-2017 (12 WAT) observations		1.5:1		
Leaf eating beetle	0.3		Coccinellids	0.4
Semi looper	0.1		Spiders	0.7
Cow bugs	2.9			
03-10-2017 (13 WAT) observations		2:1		
No. of Leaf eating beetle/plant	4.2		Coccinellids	0.1
Leaf webber	0.8		Spiders	1.1
Cow bugs	3.1			
Semi looper	0.1			
10-10-2017 (14 WAT) observations		1:1		
Leaf eating beetle	0.3		Coccinellids	0.1
Leaf webber	0.4		Spiders	1.3
Grasshopper	0.3		Praying mantis	0.3
17-10-2017 (15 WAT) observations		1:1		
Leaf eating beetle	0.1		Coccinellids	0.1
Leaf Webber	0.1		Spiders	0.5
24-10-2017 (16 WAT) observations		1:1		
Leaf eating beetle	0.05		Spiders	0.1
31-10-2017 (17 WAT) observations		0:0		
Pests	0		defenders	0

Later stage of the crop the P:D ratios were 1.5:1, 2:1,1:1,1:1 and 1:1 during 12,13,14,15 and 16 WAT respectively. Pests and defenders were not observed 17 WAT [Table-1].

Discussion

The health of a plant is determined by its environment. This environment includes abiotic factors (*i.e.* sun, rain, wind and soil nutrients) and biotic factors (*i.e.* pests, diseases and weeds). If we understand the whole system of interactions, we can use this knowledge to reduce the negative impact of pests and diseases. Pests at different places on the plant, defenders like parasitoids and predators can be observed in the field. Pest: Defender ratio (P:D ratio) safer to adopt is 2: 1. Whenever the P:D ratio is found to be favourable, there is no need for adoption of other management strategies. In cases where the P:D ratio is found to be unfavourable, the farmers can be advised to resort to inundate release of parasitoids/predators depending upon the type of pest (NIPHM). Agro ecosystem analysis (AESA) considers defenders in the field along with pest population before making any decision on pest management. Ecological engineering is 'environmental manipulation by man using small amounts of supplementary energy to control systems in which the main energy drives are still coming from natural sources' [9]. Recently EE emerged as a paradigm for considering pest management approaches that are based on cultural practices like growing flowering plants to enhance natural enemy activity to control pests [10]. In the present study P:D ration was unfavourable during 5 and 11 WAT *i.e.*, is 3:1 and 2.5:1 respectively. During these 2 weeks it was observed that any pest has not crossed Economic Threshold Level (ETL). ETL is the pest density at which control measures should be applied to prevent an increasing pest population from reaching the economic injury level [8]. ETLs for economically important pests of pigeonpea are Pod borer *Helicoverpa armigera* 5 eggs or 3 small larvae per plant, Pod fly *Melanagromyza obtusa* in all endemic locations, Leaf Webber *Maruca vitrata* 5 webs per plant [11]. Defenders were not considered in ETLs. Farmers are lacking knowledge on beneficial insects especially parasitoids and predators and their role in controlling pest, so they are using chemical pesticides indiscriminately even in the presence of beneficial insects in their field. The chemical pesticides are killing these beneficial insects along with the pest and disturbing the ecosystem. In agriculture ecosystem, crop is at 1st trophic level and man and pest are at 2nd trophic level. Man is using pesticides to kill his enemy *i.e*. pest but unknowingly also killing third trophic level insect predators and parasitoids. In the absence of natural enemy's pest population is increasing leading to the problems of pest resurgence. Indiscriminate use of pesticides leads to problem of resistance development in pests, this was observed in the pigeonpea- and chickpea-growing areas of Marathawada region of Maharashtra, significant yield losses have been reported in both crops due to incidences of pests especially *Helicoverpa*. Conventional pest management technology has achieved limited success due to pest management constraints, including development of resistance by *Helicoverpa* against major insecticides [12]. The pest problems can be managed using naturally occurring parasites, predators, and diseases to control insect and mite pests, the environment is disturbed as little as possible[11]. In our present study even though pests are present their population is very less. Entire ecosystem was self-sustained and manged favourable P:D ratio throughout crop season without the interference of external inputs like chemical pesticides. During the entire crop period important pests of pigeon pea pod borer, *Helicoverpa armigera*, spotted pod borer, *Maruca vitrata* and pod fly *Melanagromyza obtusa* were not observed and these were successfully controlled by ecological engineering practices.

Application of research: Reduction in pesticide consumption delays resistance development in many pests and by saving beneficial insects pest resurgence problems can be avoided. By knowing the importance of defenders and their role in managing phytophagous insects' farmers can avoid indiscriminate use of chemical pesticide to develop and protect sustainable agriculture ecosystem.

Research Category: Sustainable agriculture, Ecological engineering

Abbreviations: EE Ecological Engineering. AESA Agro Eco System Analysis, P:D Pest :Defender, WAT Weeks After Transplanting, ETL Economic threshold Level

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