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National Academy of Agricultural Science (NAAS) Rating : 3.03

Effect of conservation agriculture practices and soybean intercrop on incidence of gall weevil (*Alcidodes collaris* Pascoe) in pigeon pea and other insect pests

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ABSTRACT: *Habitat manipulation can even manage pests and can improve the population of the natural enemies; this was best analyzed in conservation agriculture with the present field experiment conducted during kharif 2014-15 at MARS, Dharwad. With respect to type of tillage used in both intercrop and sole, the per cent gall weevil incidence was higher in conventional tillage with flat bed and no residue mulch (21.33 % and 27.33% respectively) and least was recorded in conservation tillage with broad bed and furrow with residue retention on surface (6.66 % and 13.33 % respectively). Between the cropping systems pigeon pea intercropped with soybean recorded the lower incidence (12.89 %) than sole pigeon pea (18.78 %) i.e., 32 per cent reduction was noticed. The other insect pests recorded like pod borer was least in intercrop while the maruca was higher. However, both these are higher in conventional compared to conservation tillage practice. In soybean, defoliators are major and natural enemies like coccinellids, spiders and cadavers shown the similar results of higher population in conservation system. All these indicated the conservation tillage system involving minimum tillage, mulching and crop system diversification will favor both pest and natural enemies compared to conventional. However, the natural control will act and can manage the pests.*

Key words: *gall weevil, conservation tillage, intercrop, habitat*

INTRODUCTION

Pigeon pea (*Cajanus cajan* (L.) Millsp.) is an important multipurpose grain legume crop extensively grown in arid and semiarid tropics. There are number of insect pests which attack pigeon pea at various stages of its growth in varying intensities among them pigeon pea pod borer complex is one of the major constraint for the production. In recent years gall weevil (*Alcidodes collaris* Pascoe) has become an important pest. Which attack the pigeon pea at seedling/vegetative phase of the crop (upto 45 Days after sowing) growth particularly in the northern transitional tract of Karnataka (Puttaswamy and Devaiah, 1976; Puttaswamy *et al.*, 1977; Hugar, 2001). With respect to its bio-ecology and management the information is quite meager. But interestingly, the pest load is less with respect to pigeon pea when intercropped with soybean (2:1) as reported by Krishna Naik and Lingappa (1995).

The one more concept which is come along for the management of pests during past decades but gaining popularity again in recent days is by using biodiversity in agro ecosystems that will reduce crop losses due to pests (Theunissen and Den Ouden, 1980). A considerable amount of evidence shows that pest populations are higher, more frequent and cause greater crop losses in monocultures than in more diverse stands (Altieri and Letourneau, 1982; Cromartie, 1981), because weeds and other species of plants adjacent to or growing among crop plants provides the vital food, shelter and nesting sites for the natural enemies of pests and alters the behavioral ecology of the pest which is not desirable by the particular insect. In agriculture, crop plant species can be arranged in space by strip cropping, interplanting, mixed row cropping and as cover crops (Andrews and Kassam, 1975). A interesting compilation of a study showed that out of 50 insect pests studied thirty-five insect species were investigated for their response to plant species diversity. The majority of the insects were in the orders: Lepidoptera, Coleoptera and Homoptera accounting for 42, 32 and

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18%, respectively of the total crop pests (Baliddawa, 1985).

With the overall idea recently a concept called Conservation Agriculture (CA) is getting popularized because of its inculcation of essential components which can come in the way to manage the pests and their natural enemies. CA is one such model of sustainable agriculture with all the above mentioned categories of crop and their relative arthropod biota. It consists of mainly three principles viz., (a) zero tillage / minimum tillage/conservation tillage, (b) to retain crop residues/ maintaining the soil cover and (c) habitat or crop diversification/ crop rotation. Generally the treatments are applied for both flat bed and broad bed and furrow with or without mulch. With this background, a study initiated to know the impact of CA practices and influence of soybean as an intercrop in pigeon pea on the incidence of gall weevil. By this information our study was conducted during *kharif* 2014-15 at MARS, UAS, Dharwad with the study intention of incidence of gall weevil in these practices and also with the intercrop of soybean in pigeon pea. The other pests and their natural enemies are also recorded in both the crops and are assessed for the same type of analysis to know which type of system is better either conservation or conventional.

MATERIAL AND METHODS

The field experiment was conducted during *kharif* 2014-15 at Main Agriculture Research Station (MARS), UAS, Dharwad. The experiment was laid out in strip plot design and a strip was taken for our study. Each plot has the size of 15 m x 9m (135 m^2) and the cultivars used were JS-335 (soybean: 75 kg/ha) and TS 3R (pigeon pea: 12 kg/ha). All other crop management practices are followed as per the standard package of practice of the University. The soybean was sown with the spacing of 30 x 10 cm and pigeon pea was sown with 90 x 30 cm where according to additive series of intercropping two lines of soybean can be alternated with one row of pigeon pea (2:1). The nutrient supply c;an also be maintained with 20:40:20 kg NPK/ha for soybean and 25:50:20 kg NPK/ha for pigeon pea was applied as per the package of practice. The crops were sown during the first fortnight of July, 2014 and the observations are taken at 45 days after sowing. Randomly 50 plants were selected from each plot and recorded number of galled plants. The galled plants recorded were converted to per cent galled plants by using % galled plants (% incidence) = number of galled plants / total plants observed.

The conservation agriculture practices includes totally six treatments where all the major principles of CA are adopted *viz.,* conservation tillage with broad bed and furrow with residue retention on the surface (CT1); conservation tillage with BBF and crop residue incorporation (CT2); conservation tillage with flat bed and crop residue retention (CT3); conservation tillage with flat bed and residue incorporation (CT4); conventional tillage with residue mulch (CT5) and conventional tillage with flat bed and without mulch (CT6). These practices are same for both the intercrop and sole crop with four replications per each treatment.

In soybean, defoliators are recorded per meter row length and natural enemies like coccinellids and spiders were recorded per plant basis, while the cadavers are also recorded per meter row length. In pigeon pea for maruca readings randomly selected fifty plants were observed for the webbings in the initial stage while during later stage it also comes in pod borer complex. The pod borers are recorded by assessing five plants randomly and count the number of larvae and calculated it for percentage. The natural enemies are noted per plant.

RESULTS AND DISCUSSION

Gall weevil: Experimental data collected during the study revealed that the per cent gall weevil incidence in pigeon pea under sole pigeon pea as well as intercropped with soybean varied significantly across the different conservation tillage practices and recorded least incidence in conservation tillage with broad bed and furrow (BBF) with residue retention on the surface (CT1: 6.66%) followed by conservation tillage with BBF with residue incorporation (CT2: 7.33%). Higher incidence was recorded in conventional tillage with flat bed and no residue mulch (CT6: 21.33%). In sole pigeon pea incidence was least in CT1 (13.33%) followed by CT2 (16.00%) and was at par with conservation tillage with flat bed and residue retention (CT3: 16.00%). Higher incidence was recorded in CT6 (27.33%) as shown in Table 1.

The incidence was least in pigeon pea intercropped with soybean (12.89%) and recorded higher incidence in sole pigeon pea (18.78%) irrespective of the conservation tillage practices (Fig. 1). Thirty two per cent higher incidence in sole crop compared to intercropping with soybean. The lesser incidence of gall weevil in conservation tillage with retention of mulch on the surface might have provided ideal place for sheltering of general predators resulted in the lower incidence of gall weevil. On the other hand soybean intercropped with pigeon pea has recorded lesser weevil damage

Table 1
Effect of conservation tillage practices on incidence of gall weevil.

Tillage system		*Gall weevil (%) at 45 DAS*		
		Pigeon pea + Soybean	*Sole Pigeon pea*	*Per cent reduction over sole*
Conservation tillage with Broad Bed and Furrow (BBF) and crop residues retained on the surface	**CT1**	6.66 c (15.00)	13.33 c (21.39)	50.04
Conservation tillage with Broad Bed and Furrow (BBF) and incorporation of crop residues	**CT2**	7.33 bc (15.68)	16.00 bc (23.58)	54.19
Conservation tillage with Flat bed with crop residues retained on the surface	**CT3**	10.66 bc (19.09)	16.00 bc (23.58)	33.38
Conservation tillage with Flat bed with incorporation of crop residues	**CT4**	12.00 b (20.27)	18.66 bc (25.62)	35.69
Conventional tillage with crop residue incorporation	**CT5**	19.33 a (26.06)	21.33 ab (27.49)	9.38
Conventional tillage (Flat bed and no crop residue)	**CT6**	21.33 a (27.49)	27.33 a (31.50)	21.95
Mean population		12.89	18.78	31.36

Note: Figures in the parentheses are √x+0.5 transformed values, in a column, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT

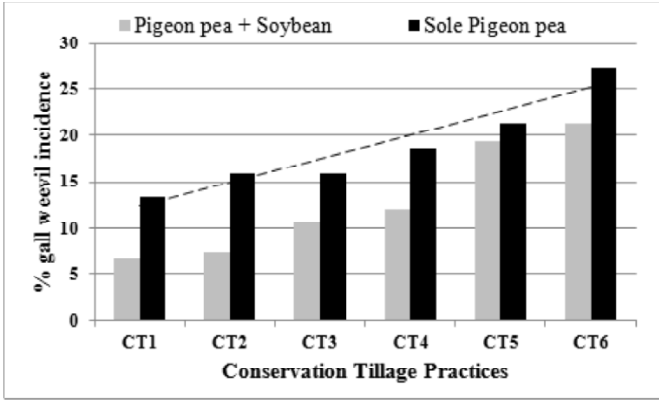

Figure 1: Incidence of gall weevil in pigeon pea

compared to sole pigeon pea, the reason may be due to secondary metabolites produced by the soybean crop might have come in the way of oviposition by the weevil or it deterred weevil from the area or cover crop which might have provided suitable habitat for generalist predators. In general all over the world, in more than 60 per cent of the intercrops recorded reduced pest incidence (Baliddawa, 1985).

Similar results were also observed by Krishna Naik and Lingappa (1995) who reported that pigeon pea with soybean as intercrop pest was effectively reduced. No reports has been so far studied regarding the tillage and its impact on gall weevil except the management practices like use of insecticides (Giraddi *et al.*, 1999; Hugar, 2001), drenching of *Metarhizium anisopliae* (Met.) Sorokin @ 2 x 10^{12} conidia/ha (Rachappa, 2003). Based on the results of the present study we can conclude that among all the management practices known so far intercropping of pigeon pea with soybean (2:1) found effective, economically feasible and easily adoptable technology.

The defoliators in soybean under pigeon pea intercropped with soybean recorded significantly higher population in CT6 (3.44/mrl) and CT5 (3.22/mrl) followed by CT3 (2.56/mrl) and least population of defoliators recorded in CT1 (1.22/mrl).

Other insect pests

Pigeon pea: The insect pest population in pigeon pea under pigeon pea intercropped with soybean varied significantly across the different conservation tillage practices. Significantly higher population of pod borer was noticed in CT1 (6.13 per plant) followed by CT2 (5.84 per plant) and least population was recorded in CT6 (2.46 per plant). While, the per cent leaf webbing caused by *Maruca* observed during 45 DAS was recorded significantly higher webbings in CT5 (22.00%) and CT6 (21.33%) followed by CT4 (13.33%). Significantly least per cent webbings were observed in rest of the treatments like CT3 (8.67%), CT2 (7.33%) and CT1 (6.67%) respectively which in turn indicates both the number of larvae and also the damage percentage. However, in sole pigeon pea the pod borer recorded per plant was significantly varied across the tillage systems and highest population was noticed in CT1 (6.63 per plant) followed by CT2 (6.13 per plant) and least population was recorded in CT6 (4.04 per plant). While, the per cent leaf webbing by *Maruca* was higher in CT6 (19.33%) and CT5 (18.67%)

followed by CT4 (9.33%) and least in CT1 (4.00%) as indicated in table 1.

In general leaf webbing due to *Maruca* at 45 DAS was higher in sole pigeon pea compared to pigeon pea intercropped with soybean. This might be due to the availability of the food source in plenty and no other food obstacles are there to deviate it from the solely maintained food source, but in intercrop it has the chance of preferring both the crops and it deviates the major damage. The similar result was also observed with the Pod borer complex where the damage was higher in sole pigeon pea compared to pigeon pea intercropped with soybean. This might also be due to the selection pressure applied on that pest where only single food source is available and the insect will feeds because of its host nature.

Natural enemies

Soybean: As indicated in table 4, the population of coccinellids was highest in CT1 (1.98/plant) followed by CT2 (1.76/plant) and least population was recorded in CT6 (0.53/plant) whereas, the spiders not varied in their readings significantly. Cadavers recorded was varied significantly across the different conservation tillage practices and noticed higher in CT1 (2.72/mrl) and least in CT5 (0.74/mrl) and CT6 (0.28/mrl) respectively. Since the soybean crop and pigeon pea both are act as cover crop and creates the micro habitat which favors the enhancement of the natural enemies and thus in turn will possibly control of the pests. Sometimes, this management will be in other hands like the well aeration and the moisture regulation in case of broad bed and furrow will also contribute for the natural enemy increase. Since, the studies regarding the effect of these components on the natural enemies is meager the possible reasons are quoted on general.

Pigeon pea: In pigeon pea intercropped with soybean the population of Coccinellids, spiders and predatory thrips were highest in CT1 (2.93/pl, 3.43/pl and 3.40/3l respectively) followed by CT2 (2.50/pl, 3.02/pl and 3.07/3l respectively) and least population was recorded in CT6 (1.28/pl, 1.37/pl and 1.60/3l respectively). However, population of predatory bugs (per plant) did not differ significantly across the tillage practices. While, in sole pigeon pea the population of coccinellids, spiders and predatory thrips were highest in CT1 (2.50/pl, 3.00/pl and 2.77/3l respectively) followed by CT2 (2.12/pl, 2.52/pl and 2.50/3l respectively) and least was observed in CT6 (0.93/pl, 1.10/pl and 1.33/3l respectively). However, similar kind of insignificant result was observed with respect to the population of predatory bugs. Overall, the population of natural enemies was highest in conservation tillage with BBF systems (CT1 and CT2) than conservation tillage with flat bed systems (CT3 and CT4) and conventional tillage systems (CT5 and CT6) as shown in table 3. Although, pigeon pea intercropped with soybean recorded comparatively higher population of natural enemies than sole pigeon pea.

Table 2
Effect of conservation tillage practices on insect pest population in pigeon pea

Tillage system		*Pigeon pea + Soybean (CS 3)*		*Sole Pigeon pea (CS 5)*	
		Pod borers/ plant	*Maruca (% leaf webbing) at 45 DAS*	*Pod borers/ plant*	*Maruca (% leaf webbing) at 45 DAS*
Conservation tillage with Broad Bed and Furrow (BBF) and crop residues retained on the surface	**CT1**	6.13 a (2.57)	6.67 c (15.00)	6.63 a (2.67)	4.00 c (11.54)
Conservation tillage with Broad Bed and Furrow (BBF) and incorporation of crop residues	**CT2**	5.84 b (2.52)	7.33 c (15.68)	6.13 b (2.57)	5.33 bc (13.31)
Conservation tillage with Flat bed with crop residues retained on the surface	**CT3**	5.15 c (2.38)	8.67 c (17.16)	5.64 c (2.48)	6.67 bc (15.00)
Conservation tillage with Flat bed with incorporation of crop residues	**CT4**	4.30 d (2.19)	13.33 b (21.39)	5.01 d (2.35)	9.33 b (17.76)
Conventional tillage with crop residue incorporation	**CT5**	3.55 e (2.01)	22.00 a (27.97)	4.40 e (2.21)	18.67 a (25.62)
Conventional tillage (Flat bed and no crop residue)	**CT6**	2.46 f (1.72)	21.33 a (27.49)	4.04 f (2.13)	19.33 a (26.06)
Mean population		4.57	13.22	5.31	10.56

Note: Figures in the parentheses are x+0.5 transformed values, in a column, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT

Table 3
Effect of conservation tillage systems on the natural enemy population in pigeon pea

Tillage system		*Pigeon pea + Soybean (CS 3)*				*Sole Pigeon pea (CS 5)*			
		Coccinellids/ plant	*Spiders/ plant*	*Predatory bugs /plant*	*Predatory thrips /3 leaves*	*Coccinellids/ plant*	*Spiders/ plant*	*Predatory thrips /3 leaves*	*Predatory bugs / plant*
Conservation tillage with Broad Bed and Furrow (BBF) and crop residues retained on the surface	**CT1**	2.93 a (1.85)	3.43 a (1.98)	0.15 a (0.81)	3.40 a (1.97)	2.50 a (1.73)	3.00 a (1.87)	2.77 a (1.81)	0.13 a (0.80)
Conservation tillage with Broad Bed and Furrow (BBF) and incorporation of crop residues	**CT2**	2.50 b (1.73)	3.02 b (1.88)	0.12 a (0.79)	3.07 ab (1.89)	2.12 b (1.62)	2.52 b (1.74)	2.50 ab (1.73)	0.10 a (0.77)
Conservation tillage with Flat bed with crop residues retained on the surface	**CT3**	2.20 c (1.64)	2.65 c (1.77)	0.08 a (0.76)	2.80 b (1.82)	1.82 c (1.52)	2.13 c (1.62)	2.20 b (1.64)	0.12 a (0.79)
Conservation tillage with Flat bed with incorporation of crop residues	**CT4**	1.82 d (1.52)	2.05 d (1.60)	0.07 a (0.75)	2.40 c (1.70)	1.53 d (1.43)	1.77 d (1.51)	1.77 c (1.51)	0.07 a (0.75)
Conventional tillage with crop residue incorporation	**CT5**	1.57 e (1.44)	1.67 e (1.47)	0.05 a (0.74)	2.00 d (1.58)	1.30 e (1.34)	1.43 e (1.39)	1.57 cd (1.44)	0.07 a (0.75)
Conventional tillage (Flat bed and no crop residue)	**CT6**	1.28 f (1.34)	1.37 f (1.37)	0.07 a (0.75)	1.60 e (1.45)	0.93 f (1.20)	1.10 f (1.26)	1.33 d (1.35)	0.05 a (0.74)

Note: Figures in the parentheses are x+0.5 transformed values, in a column, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT

Table 4
Effect of conservation tillage practices on the insect pests and their natural enemy population in soybean

Tillage system		*Natural enemies*			
		Defoliators / mrl	*Coccinellids/ plant*	*Spiders/ plant*	*Cadavers/mrl*
Conservation tillage with Broad Bed and Furrow (BBF) and crop residues retained on the surface	**CT1**	1.22 c (1.09)	1.98 a (1.58)	0.67 a (1.07)	2.72 a (1.80)
Conservation tillage with Broad Bed and Furrow (BBF) and incorporation of crop residues	**CT2**	2.11 b (1.44)	1.76 b (1.50)	0.58 a (1.04)	1.81 b (1.52)
Conservation tillage with Flat bed with crop residues retained on the surface	**CT3**	2.56 ab (1.59)	1.45 c (1.40)	0.33 a (0.90)	1.89 b (1.55)
Conservation tillage with Flat bed with incorporation of crop residues	**CT4**	2.22 b (1.48)	1.14 d (1.28)	0.40 a (0.94)	1.67 b (1.47)
Conventional tillage with crop residue incorporation	**CT5**	3.22 a (1.79)	0.78 e (1.13)	0.18 a (0.82)	0.74 c (1.12)
Conventional tillage (Flat bed and no crop residue)	**CT6**	3.44 a (1.85)	0.53 f (1.01)	0.38 a (0.92)	0.72 c (1.11)

Note: Figures in the parentheses are x+0.5 transformed values, in a column, means followed by the same alphabet do not differ significantly (P=0.05) by DMRT.

The similar trend was also observed here, this will proven the effect of different components like mulching, broad bed and furrow and intercropping. The advantages of well aerated soil, good moisture conservation in case of BBF and retaining of soil moisture, creating habitat for ground and general predators in case of mulching will help to increase the population of natural enemies and in turn those natural enemies will check the pest population of that ecosystem. Overall, the conservation agriculture inculcating all these components will certainly have the advantage over the conventional agriculture and will be the best option for achieving sustainability that's why the conservation agriculture is the best option for the future.

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