

Influence of Intercropping Unconventional Greenmanures on Pest Incidence and Yield of Cotton

K. Vaiyapuri, M. Mohamed Amanullah S. Pazhanivelan, E. Somasundaram and K. Sathyamoorthi

Department of Agronomy, Tamil Nadu Agricultural University,
Coimbatore- 641 003, Tamil Nadu, India.

Abstract: Field experiments were conducted at Agricultural Research Station, Bhavanisagar, Tamil Nadu, India to find out the effect of unconventional green manures as intercrops on the pest incidence and yield of associate hybrid cotton during the year 2003 to 2004. The soil of the experimental fields was well drained sandy clay loam. Four cropping systems viz, sole cotton, cotton + marigold (*Tageetus erectus* L.), cotton + sesamum (*Sesamum indicum* L.) and cotton + sunnhemp (*Crotolaria juncea* L.) were tested (Factor A) in single and double rows (Factor B) incorporating them on 30 and 40 DAS (Factor C). The treatments were laid out in a factorial randomized block design replicated thrice. The results revealed that intercropping with marigold in two rows in between cotton rows and incorporating it on 30 DAS had contributed ultimately less incidence of pests and more kapas and lint yield of cotton securing higher yield advantage in both summer and winter crops Sunnhemp and sesamum had moderate and low effects, respectively on pest management.

Keywords: Cotton, unconventional green manure, pest incidence, yield.

INTRODUCTION

Cotton (*Gossypium* spp.), considered as “King of Fibre” and “White Gold”, is one of the most important commercial crops grown in as much as 80 countries in the world occupying 33 m. ha. In the year 2000-01, cotton has been cultivated in our country over an area of 9 m. ha with a production of 145 lakh bales. The productivity has been arrived at 276 kg ha⁻¹^[8], which is very low as compared to the world average of 550 kg ha⁻¹ ⁽²⁾. In view of low productivity in our country, the yield enhancing practices in cotton have to be strengthened. Hybrid cotton in general has more potential than varieties. It is mostly grown under irrigation with high level of management to exploit the hybrid vigour.

Despite the largest area in the world, the cotton yield is abysmally low in India. The labour cost in cotton cultivation is 70 per cent and the balance 30 per cent is towards material cost. Despite a whooping sum of Rs.1600 crores spent on pesticides to save cotton, the pests cause considerable damage. It is the American bollworm that caused a loss of 380 crores in Punjab in 2001-02 and the major outbreak in Tamil Nadu during 2002-03 has been stem weevil. Poor rains and substandard pesticides are the other causes for low yield^[12]. While agriculture overall has reached stagnation as an after math of green revolution, cotton

has been the worst hit. Cotton is grown on 5 per cent of the land in India but it consumes about 54 per cent of the pesticides in the country^[9]. Thus the emphasis is on newer measures preferably by non-chemical, agronomic approaches for managing the pests. They have to buildup beneficial insects or as an attractant of cotton pests or both.

Green manuring is an age-old practice and even research on it has been for long. Maiden experiment on green manuring was first commenced as early as 1882 at Kanpur in India^[4]. Though it continues to be researched, while the practice of green manuring is, infact, getting phased out as it is not appealing to the farmers who do not want to give a time slot in their cropping programme to raise a green manure. Further, fertilizers come handy to them.

Green manures are neither cash crops nor food crops and this is yet another reason for green manures not becoming popular in the present day agriculture. Unlike in the past, the 'bulkiness' of green manures or for that matter of any other organic manure is a constraint in the present day agriculture. The opportunity cost of raising green manures is also less. Yet it has to be promoted due to several unfavourable effects caused by chemical agriculture widely prevalent now.

To promote greenmanuring innovations should stretch even beyond intercropping green manures and

optimizing of their rows. Cotton and plant protection are inseparable. In fact, cotton is cultivated in 5 per cent of arable area consuming as much as 50-55 per cent of pesticides used in our country^[3]. Therefore it would be significant if a greenmanure for cotton serves as a plant protectant too. Marigold is noted for the control of nematodes. Sesum is known for their root exudation. An attempt has been made in the present study to find out their pest incidence of cotton comparison with sunnhemp as standard. To find out their optimal row ratio and ideal time of incorporation, they were raised in single and two rows allowing them for 30 and 40 DAS for incorporation

MATERIALS AND METHODS

Field experiments were conducted at Agricultural Research Station, Bhavanisagar, Tamil Nadu, India to find out the effect of unconventional green manures as intercrops on the pest incidence and yield of associate hybrid cotton during the year 2003 to 2004. The soil of the experimental fields was well drained sandy clay loam. The fertility status of the soil in both the fields was low, medium and high in available N, P and K respectively. Four cropping systems viz, sole cotton, cotton + marigold (*Tageetus erectus* L.), cotton + sesamum (*Sesamum indicum* L.) and cotton + sunnhemp (*Crotalaria juncea* L.) were tested (Factor A) in single and double rows (Factor B) incorporating them on 30 and 40 DAS (Factor C). The treatments were laid out in a factorial randomized block design replicated thrice.

Cotton seeds were sown at a spacing of 120 x 60 cm. Sesamum and sunnhemp were sown in solid rows in the interspace i.e., 60 cm in between two cotton rows for single row spacing. For two rows, they were sown at 40cm interval in the interspace. In a similar way, marigold seedlings were planted keeping 10 cm intra row spacing, cotton was earthed up simultaneously at the respective incorporation timings. Fertilizers were applied at the rate of 120: 60: 60 kg N, P₂O₅ and K₂O ha⁻¹ respectively. Full dose of P & K and ½ N were applied as basal. Remaining N was applied in equal splits at the time of incorporation of green manure and at 60 DAS. Fertilizers were applied to cotton rows alone. The seed cotton was harvested in five pickings. The population of sucking pests viz., leaf hopper (*Amrasca biguttula* Ishida), whitefly (*Bemisia tabaci* Gennadius), aphid (*Aphis gossypii* Glover) and Thrips (*Thrips tabaci* Lind.) was recorded on top, middle and bottom leaves at 30, 60 and 75 DAS and expressed as number / 15 leaves. The values were subjected to square root transformation and presented. Stem weevil infestation the galls of stem weevil were recorded in 15 plants on 60 and 90 DAS and finally at

harvest (120 DAS) and the respective mean values were worked out. The values were subjected to arc sine transformation and presented. For boll worm infestation (%), both total bolls and boll worm infested bolls were counted in 15 plants and expressed as per cent boll worm infestation. The values were subjected to arc sine transformation and presented.

$$\text{Per cent infestation of boll worm} = \frac{\text{No. of bolls affected}}{\text{Total no. of bolls}} \times 100$$

RESULTS AND DISCUSSIONS

Intercropping Green Manures and Pest Incidence:

Natural Enemies: Marigold and sesamum are unconventional green manures, while sunnhemp is a known green manure. Natural enemies population was continuously more till the last observations in green manured treatments than cotton without greenmanuring. An *inter se* comparison between cotton without greenmanuring and marigold intercropping showed higher built up of natural enemies in the latter at all stages in both seasons. Row ratios and timing of incorporation of green manures had no significant impact on the population of natural enemies in both seasons.

Pests Incidence: The population of thrips, aphids, leaf hopper, white fly, boll worm and stem weevil (in terms of galls) was counted on 15 leaves in sucking pests and 15 plants with respect to boll worm and stem weevil galls and the average incidence was shown (Tables 1- 4). On an average, all these pests had lower incidence due to intercropping of green manures studied with different row ratios and timing of incorporation as compared to cotton without greenmanuring. This trend was seen in both seasons and at all stages. The impact of different green manures viz., marigold, sesamum and sunnhemp was significant in controlling all these pests but generally confined to early stage (30 DAS). Thereafter the difference due to different green manures intercropping was narrowed down and became insignificant barring stem weevil incidence. Both source of green manures raised by intercropping and row ratio had their influence in checking stem weevil incidence from 60 to 120 DAS in both seasons. Marigold intercropping had relatively low incidence of galls. Two rows of raising / planting green manures was more effective in controlling stem weevil than single row sowing / planting of green manures.

Marigold in relation to control of different pests had its prominence in checking stem weevil as could be seen from a comparison of results of sole cotton

Table1: Effect of unconventional green manure intercrops on the incidence of natural enemies, thrips in the associate cotton during summer 2003 and winter 2003-04 (No. per 15 leaves)

Treatment	Natural enemies						Thrips					
	Summer			Winter			Summer			Winter		
Stages	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS
Inter crop												
I ₁ – Marigold	3.93 (15.47)	4.75 (22.58)	3.17 (10.09)	3.42 (11.78)	4.97 (22.79)	3.41 (11.72)	3.57 (12.91)	3.94 (13.64)	3.06 (9.23)	3.15 (10.25)	3.64 (13.5)	1.87 (3.58)
I ₂ – Sesamum	3.67 (13.58)	4.59 (21.13)	2.85 (8.17)	3.35 (11.26)	4.7 (22.13)	3.28 (10.3)	3.84 (14.91)	4.49 (20.3)	3.1 (10.27)	3.56 (12.81)	4.2 (16.5)	1.94 (3.74)
I ₃ – Sunnhemp	3.89 (15.17)	4.49 (20.25)	2.83 (8.31)	3.39 (11.52)	4.76 (22.68)	3.36 (11.35)	3.69 (13.71)	4.05 (17.95)	3.29 (9.71)	3.28 (11.04)	4.13 (15.61)	1.83 (3.36)
SEd	0.15	0.06	0.2	0.08	0.07	0.22	0.1	0.27	0.16	0.1	0.24	0.09
CD (P=0.05)	NS	0.11	NS	NS	0.15	NS	0.21	NS	NS	0.2	NS	NS
Row ratio												
R ₁ – Single row	3.73 (14.09)	4.47 (20.05)	2.81 (8)	3.35 (11.28)	4.76 (22.73)	3.25 10.26	3.85 (14.89)	4.41 (19.6)	3.15 (9.87)	3.67 (13.57)	4.21 (16.71)	1.89 (3.64)
R ₂ – Double row	3.93 (15.39)	4.75 (22.58)	3.09 (9.71)	3.42 (11.8)	4.86 (23.67)	3.45 (11.99)	3.56 (12.8)	3.91 (16.33)	3.15 (9.6)	2.99 (19.16)	3.77 (13.69)	1.86 (3.49)
SEd	0.12	0.05	0.16	0.07	0.06	0.18	0.08	0.22	0.13	0.08	0.2	0.08
CD (P=0.05)	NS	0.09	NS	NS	NS	NS	0.17	0.46	NS	0.16	0.41	NS
Days of incorp.												
D ₁ – 30 DAS	3.74 (13.49)	4.66 (21.75)	2.95 (6.03)	3.38 (11.49)	4.85 (23.62)	3.37 (11.4)	3.63 (13.3)	4.2 (17.83)	3.2 (9.57)	3.3 (11.13)	3.82 (14.6)	1.92 (3.74)
D ₂ – 40 DAS	3.92 (14.74)	4.56 (20.88)	2.95 (8.86)	3.39 (11.58)	4.77 (22.72)	3.34 (10.86)	3.77 (14.39)	4.12 (18)	3.11 (9.89)	3.36 (11.61)	4.15 (15.8)	1.84 (3.38)
SEd	0.12	0.05	0.16	0.07	0.06	0.18	0.08	0.22	0.13	0.08	0.2	0.08
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cropping system												
Without GM (S ₁)	3.34 (13.47)	4.24 (18)	2.45 (6.03)	2.83 (11.58)	4.47 (20)	3.03 (9.22)	4.49 (20.25)	5.09 (26)	4.08 (13.43)	4.06 (16.52)	4.91 (21.05)	3.4 (11.79)
Overall mean (S ²) of GM	3.83 (14.74)	4.61 (21.32)	2.95 (8.86)	3.39 (8.11)	4.81 (23.2)	3.35 (11.13)	3.7 (13.84)	4.16 (17.96)	3.15 (9.73)	3.33 (11.37)	3.99 (16.12)	1.88 (3.56)
SEd	0.22	0.08	0.29	0.12	0.11	0.32	0.15	0.4	0.24	0.14	0.36	0.14
CD (P=0.05)	0.46	0.17	NS	0.25	0.22	NS	0.31	0.83	0.49	0.29	0.74	0.28

Figure in parathesis are original value

without greenmanuring and marigold intercropping (Table 4). This striking difference was seen in both seasons.

Double row intersowing / interplanting of green manures in cotton had more control on pests *viz.*, thrips, leaf hopper, white fly and boll worm in the early stages, while its effect on stem weevil was observed even at the late stages upto 120 DAS. The timing of incorporation of green manures had no relevance in controlling many of the pests including stem weevil. Thus greenmanuring of cotton by intercropping had its influence in checking various pests with marigold having marked effect on reducing stem weevil incidence.

When yield reducers in cotton are examined, it is the pests that get prominence. The simple statistics of cotton occupying 5 per cent of the area consuming 50-

55 per cent of total pesticides used in our country^[3,9] could reveal the menace of pests in cotton. In this cropping system study, there is evidence of some pest control due to intercropping green manures. Natural enemies population got increased due to intercropping green manures and their incorporation in the interspace of cotton. Higher population was maintained continuously even during later period, whereas in sole cotton the population of these predators and similar other enemies were pretty low. Increase in predator population due to cowpea intercropping with cotton^[10] and more parasitism of boll worm egg and larvae due to cotton + sorghum intercropping as observed by Mahabaleshwar Hegde *et al.*⁽⁶⁾ are supportive of observations in the present study. Saminathan *et al.*^[11] reported that there believed to be less common pests outbreak in mixed stands in line with

Table 2: Effect of unconventional green manure intercrops on the incidence of aphids and leaf hopper in the associate cotton during summer 2003 and winter 2003-04 (No. per 15 leaves)

Treatment	aphids						Leaf hopper					
	Summer			Winter			Summer			Winter		
	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS
Stages												
Inter crop												
I ₁ – Marigold	5.01 (27.22)	7.08 (50.18)	5.06 (25.65)	4.99 (24.95)	6.60 (43.74)	3.53 (12.52)	2.26 (5.14)	3.88 (15.18)	3.06 (9.41)	3.82 (14.65)	2.96 (18.60)	2.96 (8.81)
I ₂ – Sesamum	5.52 (30.55)	7.39 (54.61)	5.14 (26.49)	5.20 (27.03)	6.85 (47.15)	3.73 (13.94)	2.58 (6.66)	4.32 (18.71)	3.17 (10.09)	4.04 (16.37)	3.10 (22.50)	3.12 (9.20)
I ₃ – Sunnhemp	5.51 (30.66)	7.22 (52.12)	5.12 (26.19)	5.13 (26.31)	6.68 (44.72)	3.65 (13.33)	2.43 (5.94)	3.90 (15.29)	3.13 (9.82)	4.01 (16.07)	2.93 (20.01)	2.93 (8.57)
SEd	0.20	0.12	0.06	0.05	0.25	0.09	0.08	0.26	0.06	0.06	0.18	0.15
CD (P=0.05)	0.42	NS	NS	0.10	NS	NS	0.16	NS	NS	0.12	NS	NS
Row ratio												
R ₁ – Single row	5.34 (30.56)	7.69 (59.13)	5.14 (26.49)	5.20 (27.02)	7.06 (49.86)	3.70 (13.79)	2.51 (6.32)	4.26 (18.24)	3.13 (9.84)	4.01 (16.14)	3.06 (21.02)	3.02 (9.13)
R ₂ – Double row	5.35 (28.93)	6.77 (45.83)	5.07 (25.74)	5.02 (25.18)	6.36 (40.54)	3.56 (12.73)	2.34 (5.51)	3.80 (14.54)	3.11 (9.71)	3.90 (15.15)	2.93 (19.73)	2.99 (8.64)
SEd	0.16	0.10	0.05	0.04	0.21	0.07	0.06	0.21	0.05	0.05	0.14	0.13
CD (P=0.05)	NS	0.20	NS	0.08	0.42	NS	0.13	0.44	NS	0.09	NS	NS
Days of incorp.												
D ₁ – 30 DAS	5.20 (29.94)	7.16 (51.26)	5.06 (24.60)	5.08 (25.89)	6.65 (44.36)	3.59 (12.91)	2.32 (5.40)	3.92 (15.33)	3.10 (9.62)	3.90 (15.29)	3.04 (19.59)	3.06 (9.04)
D ₂ – 40 DAS	5.49 (30.35)	7.30 (53.29)	5.16 (26.61)	5.13 (26.31)	6.77 (46.05)	3.68 (13.62)	2.52 (6.43)	4.14 (17.26)	3.15 (9.63)	4.01 (15.15)	2.95 (21.15)	2.95 (8.74)
SEd	0.16	0.10	0.05	0.04	0.21	0.07	0.06	0.21	0.05	0.05	0.14	0.13
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.13	NS	NS	0.09	NS	NS
Cropping sys												
Without GM (S ₁)	5.95 (36.41)	8.24 (67.89)	5.79 (35.53)	5.71 (32.67)	7.24 (52.48)	4.00 (14.00)	2.61 (6.80)	5.20 (27.00)	3.57 (12.75)	4.24 (18.00)	3.55 (32.00)	3.22 (12.61)
Overall mean of GM (S ₂)	5.35 (29.64)	7.23 (52.27)	5.11 (26.11)	5.11 (26.10)	6.71 (42.50)	3.63 (13.26)	2.42 (5.91)	4.03 (16.39)	3.12 (9.77)	3.96 (17.70)	3.00 (30.27)	3.00 (8.89)
SEd	0.30	0.18	0.09	0.07	0.37	0.13	0.11	0.38	0.09	0.08	0.26	0.23
CD (P=0.05)	NS	0.37	0.18	0.15	NS	0.27	0.23	0.79	0.18	0.17	0.54	NS

(Figures in parenthesis are original values)

Table 3: Effect of unconventional green manure intercrops on the incidence of white fly and boll worm in the associate cotton during summer 2003 and winter 2003-04 (No. per 15 leaves)

Treatment	White fly						Boll worm incidence					
	Summer			Winter			Summer			Winter		
	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS
Stages												
Inter crop												
I ₁ – Marigold	3.68 (13.60)	4.42 (19.64)	3.62 (13.31)	2.76 (7.69)	3.94 (15.61)	3.62 (12.80)	33.04 (29.77)	30.93 (26.44)	20.84 (12.69)	31.70 (27.63)	35.39 (33.55)	33.39 (30.40)
I ₂ – Sesamum	3.96 (15.88)	4.96 (24.67)	3.86 (14.95)	3.17 (10.18)	4.10 (16.88)	3.86 (13.75)	36.19 (34.89)	31.91 (27.98)	21.30 (13.23)	33.53 (30.53)	36.42 (34.58)	35.51 (33.77)
I ₃ – Sunnhemp	3.76 (14.77)	4.68 (22.07)	3.68 (13.51)	2.97 (8.94)	3.91 (15.38)	3.68 (12.31)	34.36 (31.87)	31.70 (27.62)	21.89 (13.93)	32.94 (29.61)	35.52 (33.76)	34.97 (32.91)

Table 3: Continued

Sed	0.13	0.08	0.11	0.12	0.07	0.11	0.42	0.50	0.59	0.47	0.82	0.93
CD (P=0.05)	NS	0.16	NS	0.24	0.15	NS	0.86	NS	NS	0.97	NS	NS
Row ratio												
R ₁ – Single row	3.92 (15.47)	4.98 (24.84)	3.66 (13.46)	3.05 (9.39)	4.13 (17.12)	3.66 (13.33)	35.08 (33.06)	31.88 (27.92)	21.55 (13.52)	33.30 (30.17)	35.89 (33.86)	34.71 (32.48)
R ₂ – Double row	3.69 (13.63)	4.39 (19.39)	3.79 (14.42)	2.88 (8.48)	3.84 (14.79)	3.79 (12.58)	33.98 (31.29)	31.15 (26.78)	21.14 (13.04)	32.14 (28.35)	35.67 (34.07)	34.53 (32.24)
SEd	0.11	0.06	0.09	0.09	0.06	0.09	0.34	0.41	0.48	0.38	0.67	0.76
CD (P=0.05)	0.23	0.13	NS	NS	0.12	NS	0.70	NS	NS	0.79	NS	NS
Days of incorp.												
D ₁ – 30 DAS	3.76 (14.16)	4.64 (21.70)	3.75 (14.14)	2.99 (9.11)	3.93 (15.49)	3.75 (12.67)	33.75 (30.90)	31.45 (27.25)	21.01 (12.88)	31.89 (27.94)	35.79 (33.76)	34.44 (32.08)
D ₂ – 40 DAS	3.85 (14.94)	4.73 (22.57)	3.70 (13.74)	2.94 (8.77)	4.04 (16.42)	3.70 (13.73)	35.31 (33.45)	31.58 (27.44)	21.68 (13.68)	33.56 (30.58)	35.76 (34.17)	34.81 (32.64)
SEd	0.11	0.06	0.09	0.09	0.06	0.09	0.34	0.41	0.48	0.38	0.67	0.76
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.70	NS	NS	0.79	NS	NS
Cropping sys												
Without GM (S ₁)	4.28 (18.36)	5.91 (35.00)	4.15 (17.31)	3.87 (15.00)	4.69 (22.00)	4.15 (18.00)	36.07 (34.67)	36.40 (35.22)	26.46 (19.97)	36.18 (34.86)	38.96 (37.03)	37.77 (37.52)
Overall mean of GM (S ₂)	3.80 (14.55)	4.69 (22.13)	3.72 (13.94)	2.97 (8.94)	3.99 (15.69)	3.72 (12.95)	34.53 (32.18)	31.52 (27.35)	21.34 (13.28)	32.72 (29.26)	35.78 (33.96)	34.62 (22.36)
SEd	0.20	0.12	0.16	0.17	0.10	0.16	0.62	0.74	0.87	0.69	1.21	1.36
CD (P=0.05)	0.41	0.24	0.33	0.35	0.21	0.33	1.27	1.53	1.79	1.43	2.49	2.82

(Figures in parenthesis are original values)

the resource concentration hypothesis and natural enemies hypothesis. This holds good for the present study also as observed by crop diversity (cotton + green manures) recording relatively less population of all sucking, chewing and gall farming pests as compared to sole cotton.

Maradufu *et al.*^[7] and Weaver *et al.*^[13] reported the potential benefit of marigold for controlling certain specific pests. Davide^[1] reported its positive impact on nematode control. All their observations lend credence to the check on various pests observed in the present study due to intercropping of marigold which had relatively more effect than sunnhemp and sesamum.

The standing crop of sesamum has the affinity for pests such as *Heliothis*^[5]. Seed rate is also less. The branching character may also suppress the weeds. Similarly there is enough evidence to test marigold as a green manure is the interspace of cotton. Compounds extracted from the leaves and flowers of *T. minuta* are toxic to *Aedes aegypti* larvae as reported by Maradufu *et al.*⁽⁷⁾. Studies on controlling of Mexican bean weevils also indicated its usefulness⁽¹³⁾. It is known for controlling nematodes also. Further unlike grain legumes or other intercrops, these green manures could be in the field in association with cotton for a

maximum of 30-40 days only leaving large duration difference dispelling thereby any apprehension of competitiveness.

Cotton Kapas and Lint Yield:

Kapas and Lint Yield: The positive effect of intersowing and *in situ* incorporation of green manures on growth parameters and yield attributes reflected on kapas yield in both the seasons (Table 4) having thus higher yield than sole cotton (without intercropping any green manure). The yield increase was by 28.2 and 25.0 per cent due to green manuring in summer and winter seasons, respectively as compared to sole cotton. Winter season crop yielded more kapas.

As regards sources of green manures, marigold only yielded other sources and the difference was clear in winter crop. It was followed by sunnhemp. The marigold as compared to sole cotton had nearly 35.0 per cent higher kapas yield in summer 2003 crop and 39.7 per cent in winter crop. The sunnhemp had 31.0 and 24.9 per cent higher yield, respectively. The increase in kapas yield due to sesamum green manuring was marginal as compared to sole cotton. In both the seasons, double row intersowing / interplanting of green manures produced more

Table 4: Effect of unconventional green manure intercrops on the stem weevil incidence in the associate cotton and cotton yield during summer 2003 and winter 2003-04 (No. per 15 leaves)

Treatment	Stem weevil galls incidence						Kapas yield (Kg ha ⁻¹)		Lint yield (Kg ha ⁻¹)	
	Summer 2003			Winter 2003-04			Summer	Winter	Summer	Winter
Stages	60DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	Summer	Winter	Summer	Winter
Inter crop										
I ₁ – Marigold	27.61 (5.50)	15.34 (7.06)	18.51 (10.10)	14.70 (6.46)	17.11 (8.68)	19.82 (11.52)	1515	1988	485.3	621.3
I ₂ – Sesamum	29.12 (7.39)	17.36 (8.94)	21.01 (12.20)	17.95 (9.52)	19.94 (11.18)	22.43 (14.60)	1334	1633	407.6	492.2
I ₃ – Sunnhemp	28.88 (7.34)	16.06 (7.72)	19.51 (11.20)	16.58 (8.19)	18.04 (9.60)	21.52 (13.48)	1470	1778	463.2	541.3
SEd	0.48	0.24	0.63	0.30	0.52	0.87	45.37	57.90	7.94	20.6
CD (P=0.05)	0.98	0.49	1.29	0.62	1.08	1.80	93.65	119.50	16.4	42.6
Row ratio										
R ₁ – Single row	28.90 (7.44)	17.46 (9.02)	20.10 (11.80)	16.99 (8.59)	18.96 (10.30)	21.53 (13.50)	1376	1713	422.9	515.8
R ₂ – Double row	28.17 (6.08)	15.05 (6.78)	19.25 (10.50)	15.84 (7.52)	17.77 (9.34)	20.98 (12.90)	1504	1887	481.1	587.4
SEd	0.39	0.19	0.51	0.25	0.43	0.71	37.05	47.30	6.5	16.9
CD (P=0.05)	NS	0.40	NS	0.51	0.88	NS	76.46	97.60	13.4	34.8
Days of incorp.										
D ₁ – 30 DAS	28.46 (6.55)	16.13 (7.78)	19.21 (10.90)	15.91 (7.58)	18.20 (9.49)	21.09 (13.01)	1488	1855	475.3	573.1
D ₂ – 40 DAS	28.60 (6.97)	16.38 (8.03)	20.14 (11.40)	16.91 (8.53)	18.53 (10.14)	21.42 (13.40)	1393	1744	428.7	530.1
SEd	0.39	0.19	0.51	0.25	0.43	0.71	37.05	47.30	6.5	16.9
CD (P=0.05)	NS	NS	NS	0.51	NS	NS	76.46	97.60	13.4	34.8
Cropping sys										
Without GM (S ₁)	32.19 (14.85)	23.56 (16.00)	26.44 (19.80)	21.27 (13.24)	24.01 (16.56)	26.61 (20.09)	1123	1423	331.3	406.0
Overall mean of GM (S ₂)	28.53 (6.76)	16.26 (7.90)	19.68 (11.10)	16.41 (8.05)	18.36 (9.82)	21.25 (13.20)	1440	1779	452.0	551.6
SEd	0.70	0.35	0.92	0.44	0.77	1.29	66.79	85.2	11.7	30.4
CD (P=0.05)	1.45	0.72	1.90	0.91	1.58	2.65	137.85	175.9	24.1	62.7

(Figures in parenthesis are original values)

kapas yield than single row and similarly earlier incorporation on 30 DAS had favourable effect.

The interactive effect was significant and consistent with respect to row ratio and their incorporation timing. In both the years, double row of sowing / planting with early incorporation resulted in distinctly higher kapas yield. Single row and early incorporation resulted in low yield in both the seasons. The effect of green manure sources, row ratio and duration of greenmanures had similar effect on lint yield and this is in line with the fact that lint yield is a function of kapas yield.

Conclusion: The results revealed that intercropping

with marigold in two rows in between cotton rows and incorporating it on 30 DAS had contributed ultimately less incidence of pests and more kapas and lint yield of cotton securing higher yield advantage in both summer and winter crops Sunnhemp and sesamum had moderate and low effects, respectively on pest management.

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