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Intercropping Unconventional Green Manures in Cotton: An Organic Approach for Multiple Benefits: A Review

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Abstract: Cotton is a wide spaced and initial slow growing crop and therefore offers scope for intercropping green manure. Intercropping and incorporation of green manure supply nitrogen and increase the nutrient use efficiency and yield of cotton. Incorporation of leguminous green manure crops has the beneficial effect on soil fertility also. Green manure intercrop serves as plant protectant too. To start with green manures effect on the associate cotton growth and yield are reviewed hereunder followed by their effect on soil fertility, pest and weed control on the principle crop.

Key words: Cotton, green manures, pests, weeds, nutrition, growth, yield

INTRODUCTION

Cotton (*Gossypium* sp.), considered as white gold, is one of the most important commercial crops which is cultivated in India over an area of 9.1 m ha with a production of 270 lakh bales. The productivity is 503 kg ha^{-1} which is low as compared to the world average of 733 kg ha^{-1} (AICCIP, 2007).

Green manuring is an age-old practice and even research on it has been for long. Green manures are neither cash crops nor food crops and this is yet another factor for green manures not becoming popular in the present day agriculture. The opportunity cost of raising green manures is also less. Yet it has to be promoted due to several unfavorable effects caused by chemical agriculture. Cotton is a slow growing crop initially and wide spaced and consequently vulnerable for weed infestation. Cotton and plant protection are inseparable. Therefore, the green manure that is considered as an intercrop in cotton has to serve as a plant protectant too. More importance has to be attached on such green manures which offer multiple benefits in cotton.

Effect on pests: Cotton is grown on 5% of the land in India but it consumes about 54% of the pesticides in the country (Menon, 2003). 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. *Heliothis* populations were much higher on sesame intersown in cotton reducing its incidence in the latter (Laster and Furr, 1972). Suresh and Dason (1996) recorded the lowest population of leaf hopper and bollworms in cotton intercropped with black gram, cluster bean or greengram. Cotton is damaged by about 135 pest species right from crop germination to final picking. The indeterminancy of cotton also facilitates continuous food supply and shelter to the pests. Varied adverse effects are noticed due to the use of pesticides in cotton (Jambhrunkar *et al*., 1998). They suggested inter alia intercropping as one of the agro techniques to minimize the pest incidence. One of the ways to check major damage due to pests is raising intercrops with aromatic odour. Pest outbreaks in cotton are believed to be less common in mixed stands, which can be explained by resource concentration hypothesis and natural enemies hypothesis. In a survey involving crop diversity approach, minimum population was recorded in cotton +cowpea in southern districts of Tamil Nadu state (Saminathan *et al*., 2002).

Lucerne in association with cotton could promote natural enemies. Parasitis of bollworm egg and larvae was more in cotton + sorghum intercropping. Increased plant diversity and transfer of natural enemies from intercrop to main crop led to reduction in pest population as observed in cotton hybrid intercropped with cowpea, soybean, groundnut, sorghum, chilli and lucerne (Hegde *et al*., 2003). Pink bollworm incidence was significantly reduced when cotton was intercropped with maize (Kavitha *et al*., 2003).

Cotton+cowpea had maximum number of predators followed by cotton+greengram, cotton + soybean. Intercropping of cowpea and greengram could suppress the sucking pests (Mote *et al*., 2001). In Punjab alone, American boll worm attack destroyed 4.3 lakh bales of cotton valued at Rs.3.80 crores. In 2002-03 seasons, stem

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weevil incidence was widely prevalent in Tamil Nadu. Sometimes it destroys 70 to 80% of the crop in the state in summer. Weaver *et al.* (1994) observed the use of *Tagetas minuta* on controlling Mexican bean weevils. Vaiyapuri *et al.* (2008) reported that intercropping unconventional green manures in two rows in between cotton rows and incorporating it on 30 DAS ultimately had less pest incidence in associated cotton.

Effect on weed incidence: Cotton is slow growing in nature and widely spaced too. It creates suitable conditions for an increased weed competition in the crop (Kulandaivel *et al*., 2001). Weed population comprising of grasses, sedges and broad-leaved weeds were found to be significantly reduced under high density cotton and paired-row planting with blackgram as intercrop (Sankaran and Balasubramanian, 1982). Chatterjee and Mandal (1992) and Thakur (1994) have pointed out depressive effect on weed growth due to legume intercropping. Cotton + black gram and cotton + cluster bean had comparable effect to reduce the weed density and dry matter than sole cotton in rainfed vertisols. The depressive effect on weed growth was long with cluster bean in association with its prolonged duration (Solaiappan and Chellaiah, 1998). Cotton yields are reduced by 50-85% with unchecked weed growth or ineffective weed control.

Effect on nutrient status: Cotton is a heavy feeder and needs supplementation of nutrients to sustain yield. Nutrients P, K, Ca, Mg, B and Zn have influence on fruiting efficiency, whereas N, S, Mo and Mn have equal influence on vegetative and reproductive growth. But all cotton growing area in India are very poor in organic carbon, poor in available P and medium to high in available K. Buildup of soil organic matter is useful. Despite application of recommended dose of fertilizers, yield drops in the absence of organic manuring (Chittapur and Shenoy, 1998).

Studies on soil fertility due to intercropping of green manures in cotton are limited. Gidnavar *et al.* (1992) reported 0.079 to 0.088% total N at harvest of cotton due to intercropping of green manures such as sunnhemp, cowpea, horse gram and similar other four green manures as compared 0.061% in sole cotton. The P and K were also higher in green manure plots. The other favourable contribution of green manuring was higher organic carbon (0.54 to 0.63%). In a study of *in situ* green manuring and phosphate fertilization to irrigated cotton, Satheeskumar (1999) observed increase in soil available nitrogen, phosphorus and potassium at later stages as compared to sole cotton. Vaiyapuri *et al.* (2007a) observed that intercropping unconventional green manures in two rows in between cotton rows and *in situ* incorporating it on 30 DAS recorded higher nutrient uptake of cotton in both summer and winter crops and an increase in soil available nutrient status at later stages as compared to sole cotton

Effect on growth and yield: Cotton, having wider spacing in between rows, makes feasible to grow an intercrop in it (Rao, 1991). Cotton being a long duration crop provides an opportunity for *in situ* green manuring during growing period (Chittapur and Shenoy, 1998).

More than five decades back Mirchandani (1950) reported yield advantage to the tune of 15-20% in cotton due to intercropping and *in situ* incorporation of guar or sunnhemp as observed from the studies on the left bank of river Indus. The standing cotton receiving guar incorporation had better growth. Height and number of bolls were increased. There was an economic gain also due to these green manures intercropping.

Rao (1982) reported that leguminous crops like cowpea could be grown as intercrop in cotton for green manure purpose. The cowpea for fodder purpose, on the other hand, benefits the associate cotton. The rate of decomposition of legumes intercropped and *in situ* incorporated in between cotton rows followed Lucerne > sunnhemp > cowpea > horse gram > soybean > blackgram > FYM. The seed cotton yield varied in accordance with the decomposition rate and followed sunnhemp > horse gram > Lucerne > FYM > blackgram > cowpea > soybean.

Raising green manures in between cotton rows and *in situ* incorporation resulted in increased boll production and lint yield as compared to sole cotton. While cotton+ horse gram gave 14.66 q of lint ha^{-1}, sole cotton produced 11.04 q and cotton+FYM 10 t ha^{-1} yielded 12.82 q showing right choice of green manures could outweigh even FYM (Gidnavar *et al*., 1992). In a cotton + green manure intercropping study conducted at Coimbatore, India, all the four green manures tested viz., sunnhemp, lucerne, cowpea and *clitoria* had manurial effect and increased the seed cotton yield. Though the yield difference did not exist among green manure sources, sunnhemp gave some higher cotton yield than other green manures (Subramanian *et al*., 1995). Vaiyapuri *et al.* (2007b) reported that the overall effect of intersowing and *in situ* incorporation of green manures on kapas yield was significant in both the seasons as compared to sole cotton (without intercropping any green manure). The yield increase was by 28.2 and 25.0% due to green manuring in summer and winter seasons, respectively as compared to sole cotton.

There are reports of yield reduction in cotton due to intercropping of green manures. At Banswara, Central Zone, intercropping and *in situ* incorporation of

greengram, cowpea and sunnhemp decreased the yield of cotton considerably, whereas, FYM at 5 t ha^{-1} resulted in higher yield of kapas (AICCIP, 1999). Recently, Katkar *et al.* (2002) reported 15% increase in cotton yield due to green manuring with sunnhemp. Thus from most of the studies, advantages of intercropping of green manures in cotton are seen. Few reasons such as short growing season of cotton if any, prolonging turning time might be detrimental.

Effect on yield and return: In earlier years, mixed cropping was in vogue. Ducker and Hozle (1948) reported reduced yield of cotton when grown as a mixture. Iyer (1950) listed 22 crops, which lend themselves for cultivation along with cotton. Cotton inter sown in groundnut had no yield reduction as compared to sole cotton in two out of three years. But the return due to cotton + groundnut mixed cropping was promising as compared to sole cotton Similar was the report of Divekar and Kurtakoti (1961). Cotton + mung at 1:1 ratio resulted in nominal reduction in cotton yield but an yield of 462 kg ha^{-1} of mung was obtained due to intercropping. The wheat that followed cotton was also benefited. But intercropping of cotton with cowpea in different proportions did not prove beneficial under grain purpose cultivation (Singh and Singh, 1973).

Bavale and Vyahalkar (1981) observed that intercropping of legume significantly reduced the yield of seed cotton significantly. However urd as an intercrop did affect the seed cotton yield only very marginally by 3% but gave an extra yield of 280 kg ha^{-1} of urd and gave the highest monetary return. Mung reduced the seed cotton yield, while cowpea raised as fodder and cowpea raised and incorporated *in situ* did not affect the seed cotton yield. Monetary returns were, however, more with cotton+mung as compared to sole cotton (Rao, 1982). Intercropping of cotton with legumes such as greengram, black gram and groundnut as well as non-legumes such as foxtail millet, maize, chilli, onion etc., have been found to be profitable in the Central and Southern cotton zones.

Short duration greengram and black gram gave the best results with 5-6 q of pulse ha^{-1} maintaining the cotton yield at the same time (Basu, 1985). Soybean and cowpea as intercrops suppressed the seed cotton yield, while onion enhanced the seed cotton yield and also seed cotton yield equivalent (Babu, 1998). Sole cotton yield was higher in both the years of study as compared to intercropped cotton. The reduction in seed cotton yield (rainfed) was 7.9 and 10.3% in black gram and 13 and 13.9% in cluster bean during 1993-94 and 1994-95, respectively (Solaiappan *et al*., 1999).

Chellamuthu and Ramaswami (2000) reported that cowpea and black gram as intercrops increased the seed cotton yield, while greengram and soybean were not so as for as base crop yield was concerned. Vaiyapuri *et al.* (2007c) reported that intercropping unconventional green manures in two rows in between cotton rows and in situ incorporating it on 30 DAS had contributed ultimately more kapas and lint yield of cotton securing higher yield advantage in both summer and winter crops. Higher net return and BC ratio were obtained when intercropping with marigold in two rows in between cotton rows and incorporating it on 30 DAS.

Thus, from the distant years of study to recent ones, it is seen that many grain legumes did not affect the cotton yield (if at all only slightly) and overall returns were found higher. The point of observation of this review is that with proper choice of a component, cotton yield might not be affected. But with green manure intercropping with far higher duration difference, the expected benefits might be still higher.

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