

Review Article

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A Review: Effect of Inter Cropping in Horticultural Crops

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ABSTRACT

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Mono-cropping style production has significant problems and that there exists a sufficient justification for studying intercropping approaches. Intercropping provide insurance against risk and give stable returns even under unfavorable weather conditions. The most common advantage of intercropping is the production of greater yield on a given piece of land by making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, height and nutrient requirements based on the complementary utilization of growth resources by the component crops. The objectives of this review are to assess the available literatures on the intercropping systems, to show the scientific justifications on the advantages and disadvantages of the system in an attempt to provide the comparative advantages over the mono-cropping system and to indicate as the system can allow more efficient uses of on farm resources like water in order to enable sustainable crop production for a nation.

Introduction

Intercropping is the growing of two or more crops simultaneously on the same field such that the period of overlap is long enough to include the vegetative stage (Gomez and Gomez, 1983). Intercropping, double cropping and other mixed cropping practices that allow more efficient uses of on farm resources are among the agricultural practices associated with sustainable crop production (NRC, 1993; Tolera, 2003). Intercropping provides year-round ground cover, or at least for a longer period than monocultures, in order to protect the soil from desiccation and erosion. By growing more than one crop at a time in the same field, farmers maximize water use efficiency, maintain soil fertility,

and minimize soil erosion, which are the serious drawbacks of mono-cropping (Hoshikawa, 1991).

It also reduces seasonal work peaks as a result of the different planting and harvesting times of intercropping crops. Moreover, it could serve to increase output per unit area, particularly with low levels of external inputs since a mix of species makes better use of available nutrients and water in the soil (Kotschi *et al.*, 1986). Numerous researchers cover the theory and mechanisms of yield stability in intercropping. Willey (1979) clearly and evidently proposed that intercropping gives higher yields in a given season and greater stability of yields in different seasons compared with sole

cropping. Moreover, Mead and Willey (1980) stated in detail that in intercropping systems, yields are more stable. Its relation to yield stability is the notion of risk, in terms of either productivity or income or both.

Beets (1982) thought that crop insurance was a major principle of intercropping in that if environmental factors change, some of the intercrop does well when others do poorly. He thought that for intercropping to be risk advantageous, the components of the crop association needed to have different environmental requirements or contrasting habits. Clawson (1985) concluded that traditional farmers cultivate a great variety of crops in order to maximize harvest security. This included intra species diversity such as different colors of maize with different maturation times. Wolfe (1985) reported that grain mixtures can generally provide a better guarantee of high yield than a priority choice of a single best variety, largely due to the unpredictability of the growing season.

Intercropping is a technique of crop intensification in both space and time where in the competition between crops may occur during a part or whole of crop growth period. It has been a common practice followed by the farmers of India, Africa, Sri Lanka and West Indies (Andrews and Kassam, 1979). Intercropping is an excellent system of cropping which ensure better utilization of resources and inputs if the selection of crops were made appropriately (Singh *et al.*, 2014). The basic idea of intercropping is not only that two or more crop species grown together can exploit the resources better than either of them grown separately, but also to cover inherent risk in agriculture and more so, under dry land condition which is buffer to some extent and is called as “biological insurance” (Ayyer, 1963).

Dodiya *et al.*, (2017) reported T7 (Sole jasmine) recorded significantly maximum

PAR and leaf temperature during second intercropping season while the data recorded during first intercropping season showed non-significant effect.

Abd El-Gaid *et al.*, (2014) reported highest LER in 1:3 tomato and common bean planting system as 1.26 and 1.25 in first and second season, respectively. It is recommended to use this pattern to improve farmer's income and LER under New Valley conditions. Agrawal *et al.*, (2010) observed maximum cauliflower yield in cauliflower + fenugreek (16.58 t/ha) intercropping system followed by cauliflower + marigold (14.80 t/ha) and minimum was noted with cauliflower sole (14.22 t/ha).

The significant increase in equivalent yield was observed when jasmine intercropped with vegetable cowpea (45 cm x 15 cm) which recorded 5170.36 g/plant and 12925.90 kg/ha. This was comparatively followed by jasmine + small vegetable cowpea (60 cm x 15 cm) which registered 5095.35 g/plant and 12738.37 kg/ha, while the lowest yield per plant (4700.25 g/plant) and per hectare (11750.62 kg/ha) were observed in the sole jasmine (Anburani and Vidhya priyadharshini, 2011)

Anburani and Vidhya Priyadharshini (2011) noticed the maximum number of productive shoots (235.98) in jasmine intercropped with vegetable cowpea at a spacing of 45 x 15 cm. The lowest number of productive shoots (204.29) was observed in Sole jasmine. Aravazhi *et al.*, (1996) found that reduction in growth characters of chilli was more with lab-lab bean and radish than other intercrops like onion, french bean and black gram.

Availability of environment resources to each of component crop is important in determining combined productivity of intercrop. The competition abilities of component crops determine their biomass production and yield often varies according to

growth environment (Fukai and Trenbath, 1993). Chundawat and Gupta (1974) suggested growing of hardy and early bearing fruit crops like phalsa as filler crop in mango groves. This would provide economic support to fruit growers.

Das *et al.*, (2008) revealed that the plant height of tamarind (191.75 cm) was much influenced by turmeric intercrop which was at par with chilli and elephant foot yam. The maximum canopy spread was recorded with tamarind + elephant foot yam (185.74 cm) in N-S direction and with tamarind + turmeric (192.43 cm) in E-W direction. In case of basal girth it was maximum in chilli (13.13 cm) and minimum with ginger (10.60 cm).

Donald (1963) opined that species of contrasting habit, both morphologically and physiologically would together be able to exploit the total environment more effectively than monoculture. If two species grown together are mutually beneficial, then there is cooperation. On the contrary, competition results when they tend to be mutually harmful and this competition is mainly for water, nutrients and light.

The relationship of competition and cooperation is density dependent. The resources with regard to plant nutrients present in the soil or added to it as manure were utilized to the fuller extent in mixed stand than when components were grown separately. The crops with varying root depth, tap different layers of soil for plant nutrients and moisture. The periodical return and distribution of labour requirements throughout the year is of great help to the resource poor cultivators (Aiyer, 1949). Gawade *et al.*, (2003) recorded the significantly highest monetary returns (Rs. 1,24,309) in cauliflower intercropped with palak than remaining combinations.

Ghanbari *et al.*, (2010) studied the effect of

maize and cowpea intercropping on light distribution, soil temperature and soil moisture in arid environment and observed that there was significant difference in light interception between the cowpea and maize pure stands as compared to the intercrop.

Ghosh (2001) found that highest monetary returns per ha was registered from guava + ground nut (Rs. 39,685) whereas, the net profit per ha was recorded maximum under guava + ridge gourd (Rs. 21,368) followed by guava + ground nut (20,685) combination.

Ghosh and Hore (2011) noticed that the cropping system model (coconut + lime + ginger + okra) was found best among all. Further, planting with 25-30 g seed rhizome at 20 cm × 15 cm spacing may be recommended for ginger as intercrop in coconut plantation for maximizing the yield.

Ghosh *et al.*, (2004) studied colocasia as an intercrop in arecanut cv. Mohitnagar plantation and found beneficial effect of colocasia on the growth of arecanut at Nadia, West Bengal. They found increment in plant height (65.73%) and number of leaves per plant (72.82%) due to intercropping.

Gill and Ajit (2006) conducted intercropping studies to determine the effect of four different varieties (Amrapalli, Dashehari, Mallika and Langra) of mango on yield of wheat sown in the interspace of the mango cultivars. Highest grain and straw yield of wheat were recorded in variety 'Amrapalli'.

In intercropping, lot of methodology has been developed for comparison. However, the most convincing is monetary return from suggested cropping system.

Intercrop reduced yield as compared to monoculture but in most of intercrops it increases the overall profit (Singh 1985).

Intercropping of okra + maize reduced the

growth of okra and maize crop with respect to their monoculture. However, with increased plant density of maize in intercropped okra, enhancement was observed in plant height and leaf area index but decrease in number of branches of maize plant (Mouneka and Asiegbu, 1997).

Islami *et al.*, (2011) studied intercropping of different field crops in cassava and found that all intercropping systems had LER greater than 1 which varied between 1.35 (cassava + upland rice) and 1.6 (cassava + peanut) which shows the profitability of intercropping.

It is observed that crop mixture provide insurance against risk and give stable returns even under unfavorable weather conditions. The major way of the crop mixture can achieve greater stability is from the compensation of one component crop when other fail or grow poorly, because of drought, pest or disease. But when two species are grown separately as sole crops, there is no possibility of compensation. Intercropping would ensure low yield fluctuations than sole cropping even under unfavorable condition (Oguntowara and Norman, 1974). The crop mixtures would also stabilize returns over seasons as they provided more than one commodity and can act as buffer against frequent price changes in any one of component crops (Rao and Willey, 1980).

Krishna *et al.*, (2011) studied the production potential of vegetable cowpea intercropped in jatropha based cropping system under dryland conditions. Among the three different tree spacings of jatropha, growth and yield of cowpea was higher when grown in the interspace of Jatropha trees at 4.0 m x 3.0 m spacing.

Kumar *et al.*, (2011) studied the effect of castor based intercropping system on yield and post-harvest nutrient status of soil and observed that available nitrogen, phosphorous

and potassium content of soil were higher (299 kg/ha, 38 kg/ha and 309 kg/ha, respectively) when castor intercropped with ground nut in 1:3 row proportion as compared to sole cropping (280 kg/ha, 33 kg/ha and 298 kg/ha, respectively).

Lakshminarayanan *et al.*, (2005) conducted an experiment on intercropping of leguminous vegetables in a pruned field of jasmine (*Jasminum sambac* L.) and they observed that intercropping significantly altered the growth of jasmine. Pure crop of jasmine recorded maximum plant height (85.18 cm) which was found to be on same bar with jasmine + cluster bean 1:1 (80.76 cm). They also indicated that intercropping of pruned jasmine with double rows of vegetable cowpea fetched highest land equivalent ratio (1.99). As well as, they also suggested that intercropping of pruned jasmine with double rows of vegetable cowpea fetched the highest equivalent yield of jasmine (5393 kg/ha) as compared to sole jasmine (3049 kg/ha).

Mahant (2011) inferred that intercropping in banana was more productive and profitable than their sole cultivation without loss in yield. Intercropping either with onion or garlic in banana at initial growth stage of planting increase the total profit without affecting the yield, he also observed that intercropping with garlic and onion with 60% coverage in banana under drip irrigation gave maximum gross and net returns as well as benefit cost ratio. They also noticed LER values in all the treatments were greater than one indicating the profitability of intercropping over sole cropping. Maximum LER was recorded in banana + onion (1.60) followed by banana + garlic (1.56) and banana + cauliflower (1.54). Mandal *et al.*, (2004) reported that highest LER (1.76) was recorded when mulberry and groundnut was intercropped at 1:4 ratio followed by mulberry + green gram intercropping system.

Math *et al.*, (2012) observed that, the available N, P and K status was improved by growing soybean and french bean in 1:2 row ratio with maize (221.33 and 245.43 kg/ha, 36.42 and 35.32 kg/ha and 366.45 and 369.62 kg/ha, respectively) as compared to sole maize (221.33, 32.28 and 361.58 kg/ha, respectively).

Misra *et al.*, (1984) reported that intercropping of French bean in orchard of apple cv. Red Delicious as an orchard floor management practice did not have any adverse effect on growth of apple. Mithamo (2014) conducted an experiment on intercropping of coffee with fruit trees and studied the effect on eco-physiological and soil factors of coffee and observed that intercropping of coffee with fruit trees significantly reduced coffee PAR (Photosynthetically Active Radiation) and did not significantly influence the leaf temperatures, during the cold season.

Natarajan (1992) found that plant height and number of branches in chilli were considerably reduced due to intercropping with okra, onion, coriander and black gram as compared to mono culture.

Nedunchezhiyan *et al.*, (2002) conducted an experiment to study the suitability of elephant foot yam as an intercrop in banana and papaya gardens. They revealed that elephant foot yam can substantially increase the net returns from banana (Rs. 21,100.00) and papaya (Rs. 20,200.00) cultivation without any adverse effect on the main crop. Nedunchezhiyan (2014) studied intercropping of spices (turmeric and ginger) in elephant foot yam and found maximum LER (1.10) was noticed in elephant foot yam + ginger (1:2) intercropping followed by elephant foot yam + ginger 1:1 (1.06) and elephant foot yam + turmeric 1:1 (1.02).

Prakash *et al.*, (2009) revealed that cultivation of sugarcane in spring planting with intercropping the marigold (Pusa Narangi Gainda) increased the sugarcane productivity, organic carbon and marigold flower (74 q/ha), increased the additional income (0.74 lakh/ha) in year 2005 and 0.86 to 1.63 lakh/ha in year 2006, respectively.

Prakash *et al.*, (2011) noticed that the gross monetary return was higher in sugarcane + gladiolus intercropping system in comparison to cucumber, okra and French bean. The maximum sugarcane yield (900 q/ha) was found in french bean intercropped with sugarcane and soil health was also improved. Among the intercropping system sugarcane with gladiolus was more remunerative in respect of net return.

Rahman *et al.*, (2006) reported the highest LER from banana (Ranginsagar) + potato (1.68) and the lowest (1.42) from banana (Sabarai) + mustard.

Sarma *et al.*, (1996) observed that higher input: output ratio was found in case of colocasia. Yield of the main crop was not affected due to any of the intercrops. On the contrary, yield reduction was noticed when coconut was grown as pure crop. A substantial increase in nut yield was observed due to intercropping with ginger and colocasia.

Sharma and Tiwari (1996) intercropped tomato with maize with one row of maize alternating with 1, 2, 3 or 4 rows of tomato. As the frequency of maize rows maintained, light intensity, soil temperature as well as increase the yield.

Shrestha (2012) conducted an experiment on intercropping of five tomato varieties Pusa Ruby, CL-1131, BARI-4, BARI-5 and Bio-Rakshya in newly established mango orchard.

Out of which highest fruit yield and economic benefit was obtained from variety Pusa Ruby and recommended it for intercropping in young mango orchard.

Singh and Datta (2006) reported that intercropping of french marigold with gladiolus paired system gave an additional yield than pure cropping of gladiolus paired system. The net income due to the intercropping was almost two fold higher than the pure cropping of conventional practice at 40 cm × 15 cm spacing. Marigold being the dissimilar growth pattern did not have any detrimental effect on productivity of gladiolus crop. Thankamani *et al.*, (2011) studied the different treatment combinations with cassava, elephant foot yam, coleus, ginger, turmeric, hybrid napier, congo signal grass, and guinea grass intercropped in black pepper garden. They recorded the highest LER (2.1) in hybrid napier followed by elephant foot yam (1.70) and guinea grass (1.70).

The crop yield is end product of many plant growth processes which interact with environment. The growth environment encountered by a component in an intercrop is generally different from that in sole crop. The nature and degree of difference is depends on plant type of (e.g. plant height and spreading) associated crop. The reduction in growth of intercrop over sole crop may also be due to the higher competition for light, nutrients and moisture (Singh, 1985).

Another important reason for intercropping is the improvement and maintenance of soil fertility. This is reached when a cereal crop (such as maize or sorghum) or a tuber crop (such as cassava) is grown in association with a pulse (beans, peas, etc.) (Geno and Geno, 2001). They also reported that deep-rooting pulse crops, such as pigeon pea, also take up nutrients from deeper soil layers; thereby recycle nutrients leached from the surface.

Legumes also grow well in soils low in phosphate (Geno and Geno, 2001); after the intercrop is harvested, decaying roots and fallen leaves provide nitrogen and other nutrients for the next crop. This residual effect of the pulse crop on the next crop is largest when the remains of the pulse are left on the field and ploughed under after harvest. However, when a large amount of nitrogen is removed in the grain harvest, more nitrogen is removed from the field than fixed by the pulse crop (Geno and Geno, 2001). Thus soil depletion can still occur in a grain pulse intercrop when the nutrients taken up by the crops are not replaced with manure or fertilizers (Giller, 2001). In intercropping, nitrogen fixation by the legume is not enough to maintain soil fertility. A basal fertilizer is generally needed for both the cereal and the legume. Fertilizers are more efficiently used in an intercropping system, due to the increased amount of humus and the different rooting systems of the crops, as well as differences in the amount of nutrients taken up.

As a general conclusion, through intercropping, farmers can achieve the full production of the main crop and also an additional yield (bonus) associated with an increased plant population of the second component. Hence, intercropping can increase income obtained by smallholder farmers through reduction of economic risk and market fluctuation resulting from growing a single crop which is more prone to natural hazards and helping the farmers in better utilization of land by having more than one crop produced per unit area. Intercropping provide insurance against risk and give stable returns even under unfavorable weather conditions. Though all intercrops produced higher productivity, the farmers could better use the appropriate population of component crops in intercropping systems in order to maximize yield of both crops as well as total

productivity. It is, therefore, important to support intercropping systems with appropriate agronomic practices such as timely irrigation, pest protection and the likes to sustain the cropping system. It is also useful when main crops fails due to natural hazards like insect-pest attacks on main crops.

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