Effect of Flower crops as intercrop in different cropping systems: A Review

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Abstract - Farmers need to address climate change by practicing ecological intensification to enhance food production, bolster resilience to extreme weather and reduce agriculture's carbon footprint. Intercropping, the practice of growing two or more crops simultaneously in the same field, has gained considerable attention for its potential to improve agricultural sustainability and productivity. While traditional intercropping systems often involve combinations of staple food crops, recent research has explored the integration of flower crops into such systems to enhance biodiversity, ecosystem services and economic returns. It improves resource efficiency, augments soil water retention and fosters habitat diversity for beneficial insects crucial for pollination and pest control. Despite these advantages, intercropping faces limited adoption due to perceived risks such as potential yield reduction, heightened management complexity, a steep learning curve and increased susceptibility to pests. Overall, integrating flower crops into intercropping systems holds promise for enhancing agricultural sustainability, resilience and multifunctionality. This abstract presents a synthesis of recent studies examining the benefits and challenges of flower crops as intercrop.

Index Terms – Intercrop, Flower crops, Types, Advantages, Limitation.

1.INTRODUCTION

Intercropping is a multiple cropping practice that involves growing two or more crops simultaneously in proximity. The primary aim is to enhance overall yield and improve crop quality on a given piece of land by efficiently utilizing resources that might otherwise be underutilized by a single crop. Intercropping horticulture and floriculture crops in a single field not only boosts profits for floriculturists but also ensures more favorable returns. Flower crops play a significant role in both daily life and the national economy. Consequently, the practice of intercropping commercial flower crops has been steadily increasing in recent years (Nrithung *et al*., 2021).

India has a rich tradition in floriculture and gardening, with flower cultivation being a longstanding practice. Despite its historical roots, floriculture has evolved into a lucrative business only in recent times. The cultivation of flowers is considered as profitable trade sector, presenting the potential to generate self-employment opportunities among farmers with low and moderate incomes**.**

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2. Types of intercropping:

The intercropping is divided into the following eight groups (Vandermeer, 1992).

a) Strip intercropping:

In strip intercropping, crops are planted in alternating strips or rows within the same field. This method allows for efficient use of space and resources, as different crops can have complementary growth patterns and nutrient needs.

b) Mixed intercropping:

Mixed intercropping involves planting different crops together within the same row or plot, without a distinct pattern. This method promotes biodiversity and can enhance soil fertility by diversifying root structures and nutrient uptake.

c) Row intercropping:

Row intercropping involves planting one crop in rows with another crop planted in between the rows of the primary crop. This method maximizes space utilization and can provide benefits such as improved weed suppression and increased yield stability.

d) Relay intercropping:

Relay intercropping involves planting a second crop into an already established primary crop before its harvest. This method allows for efficient use of time and space, as the second crop can utilize available resources without competing with the primary crop during its early growth stages.

e) Agroforestry intercropping:

Agroforestry intercropping involves combining trees or shrubs with agricultural crops. This method enhances biodiversity, provides additional income opportunities through timber or fruit production and offers environmental benefits such as carbon sequestration and soil conservation.

f) Cover crop intercropping:

Cover crop intercropping involves planting a cover crop alongside the main cash crop. Cover crops can provide numerous benefits, including weed suppression, soil erosion prevention, nutrient cycling and soil improvement.

g) Temporal intercropping:

Temporal intercropping involves planting crops with different growth durations in the same field. This method allows for efficient use of land over time and can help maximize yields by continuously providing harvestable crops throughout the growing season.

h) Trap cropping:

Trap cropping involves planting a less desirable crop to attract pests away from the main crop. This method helps in pest management by reducing pest pressure on the primary crop and can minimize the need for chemical pesticides.

Intercropping provides a higher yield income per unit area compared to growing single crops alone. This practice also helps to maintain soil fertility by utilizing nutrients from different layers of soil. Additionally, intercrops also contribute to a reduction in runoff and effectively control weed growth (Hailu G, 2015).

3. Prerequisites and principles for successful intercropping:

The peak nutrient demand of individual crops does not coincide, minimizing competition for light among the component crops, fostering complementary relationships between them and ensuring a minimum 30-days difference in the maturity of the component crops.

Secondary crop should take a subordinate position, discouraging tall and excessive growth. It is essential to avoid depleting soil water and nutrients and the use of perennial crops as intercrops should be discouraged (Khanal *et al.*, 2021).

4. Advantages:

Intercropping with flowers offers several advantages, leading to augmented profits and more efficient land utilization. This practice safeguards the primary cash crop, curbing soil erosion and crust formation. Additionally, it contributes extra nutrients to the main crop, reducing the need for synthetic fertilizers and promoting the optimal utilization of natural fertilizers. Furthermore, flower intercropping enhances weed management, fostering a diverse and ecologically stable (Mousavi and Eskandari, 2011).

Intercropping cauliflower with balsam has proven to enhance both the size and quality of cauliflower, while simultaneously increasing the number of balsam flowers and overall yield. This intercropping method stands out as the optimal treatment, especially considering the high demand for balsam as loose flowers at the onset of the festival season in September - October. Additionally, the inclusion of cauliflower as a companion crop not only contributes to improved yields but also serves as an additional source of income for growers. Ultimately, adopting this approach is poised to boost farmers' income significantly (Mondal *et al*., 2018).

An experiment was undertaken to examine how the growth and productivity of red ginger cultivated in mature oil palm were influenced by the application of primary nutrients (NPK in inorganic form). The treatment T_4 (10:20:20 NPK/clump) resulted in maximum plant height of 124.14 cm and the highest number of leaves per plant, averaging 39.33. Treatment T_7 (20:10:20 NPK/clump) exhibited the longest spikes, averaging 20.29 cm

and the highest number of spikes per clump, with an average of 18.29. Notably, treatment T_4 (10:20:20 NPK/clump) yielded the maximum number of bracts per spike, averaging 16.95. Among these treatments, the fertilization dosage of 20:10:20 NPK/clump, equivalent to 88.8 - 44.4 - 88.8 kg NPK ha^{-1}, demonstrated the most favorable outcomes for red ginger yield (Motha *et al*., 2018).

4.1. Increases profit

Intercropping increases crop production rate with the added benefit of lowering the risk of total crop loss. Field's diversity and stability, reduces the use of chemicals and fertilizers, mutually benefitted by exchange of plant resources.

Research on ten rose cultivars namely Hybrid Tea and Floribunda groups were grown under three years and 52 years old coconut plantations as a intercrop (Veluru *et al.,* 2021). Between both types of coconut plantation, superior growth and flowering was noticed in roses grown under young plantation (3 years) as compared to old coconut plantation (52 years). The benefit-cost ratio (BCR) of rose as intercropping with coconut was found to be 1.38 with an internal rate of return (IRR) of 22 per cent as against 1.24 and 14% without intercropping.

4.2. Enhancement of bio diversity and ecological stability

Intercropping diminishes reliance on chemical pesticides, rendering cultivation economically viable by lowering production costs. It mitigates environmental and health risks while efficiently managing target pests. Additionally, it promotes the conservation of natural enemies and beneficial organisms, contributing to the maintenance of biodiversity.

Two repellent plants, marigold flower (*Tagetes erecta* L.) and onion (*Allium cepa* L.) were intercropped with pak choi (*Brassica rapa* chinensis) in an attempt to lower pest abundance and damage to foliar. Results indicated marigold intercrop was effective in lowering the population of two common cabbage pests, *Plutella xylostella* and *Psylliodes chrysocephala*. Onion intercrop and control treatment (sole pak choi) did not show any significant differences in the response variables *i.e*., pest abundance, defoliation (%) and leaf area index (Lamba and Homband, 2020).

To control aphids broccoli is intercropped with strips of alyssum (*Lobularia maritima* L.) which attracts hoverflies, that are important predators of aphids. The A100 pattern appears to be the most effective alternative intercropping approach for ensuring hoverflies and parasitoids have access to floral resources throughout the entire season. However, employing additive intercropping may also prove beneficial in enhancing floral resources early in the season without displacing broccoli. These findings offer valuable insights for growers aiming to decrease the expenses associated with alyssum intercropping in high-density broccoli systems exceeding 1,00,000 transplants per hectare (Brennan, 2016).

Effects of trap crops against chilli pests was assessed by Sujay and Giraddi (2016). The chilli trap intercropped with marigold demonstrated the lowest larval population and fruit borer damage. Conversely, the sole chilli crop exhibited significantly higher populations of sucking pests, leaf curl index, larval population of *H. armigera* and fruit damage. The chilli trap intercropped with marigold resulted in the highest net return of ₹17,729. This was followed by the chilli trap intercropped with tomato, which yielded 3.29 q/ha. Conversely, the sole chilli crop yielded the minimum with a net return of ₹ 2,511 and a cost-to-benefit ratio of 1:1.22.

Evaluation of different integrated pest management (IPM) modules against the tomato fruit borer, *Helicoverpa armigera* Hubner was carried out by Karabhantanal *et al.* (2005). The integrated pest management (IPM) module, comprising a trap crop of 15 rows of tomato to one row of marigold, along with *Trichogramma pretiosum* at a rate of 45,000/ha, NSKE at 5%, HaNPV at 250 LE/ha and endosulfan 35 EC at 1250ml/ha, demonstrated significant superiority over other tested modules in controlling larval populations, achieving a 100% reduction after the fourth spray. Consequently, this module resulted in the lowest fruit damage rate of 11.87%, the highest marketable fruit yield of 224.56 q/ha and an additional net profit of Rs. 22,915/ha.

4.3. The Land equivalent ratio (LER): - it is a measure comparing the area required for sole cropping to the area needed for intercropping to achieve equivalent yields under identical management conditions. LER > 1 indicates the advantage of intercropping, LER < 1 signifies a disadvantage and LER = 1 implies no difference in yield between the two cropping methods (Mead & Willey, 1980).

Jasmine is intercropped with different annual flowers to increase the productivity per unit area. The economic analysis of different intercropping systems indicated that jasmine with French marigold (1:2) was most profitable system which recorded higher jasmine equivalent yield, land equivalent ratio and net realization while benefit cost ratio was obtained higher under jasmine with African marigold (1:1) (Dodiya *et al*., 2016).

4.4. Nutrient uptake by plant

Intercropping offers the advantage of optimizing resource utilization through niche differentiation and complementarity. It not only enhances nitrogen absorption by crops but also facilitates the uptake of phosphorous and potassium.

Research work on five flower crops namely jasmine (kakada), chrysanthemum, crossandra, china aster and marigold grown in the inter-row spaces of coconut proved that the leaf nutrient status of coconut was significantly influenced by flower crops. Nitrogen content was found to be maximum in coconut and chrysanthemum intercrop. Phosphorous content was more in case of coconut and jasmine intercrop. Whereas potassium content was maximum in coconut and china aster intercropping (Basavaraj *et al*., 2018).

A study was conducted for standardising the nutrient management practice for marigold-globe amaranth sequential cropping under coconut-based farming system (Nihad *et al.*, 2017). The plant height, number of primary and secondary branches, number of flowers plant^{-1}, flower yield and flower carotenoid content of marigold were higher in 50%VC+NPK+VCE treatment. The investigation demonstrated that replacing half of the inorganic nitrogen needed for marigold with vermicompost not only improves its growth but also offers sufficient nutrition for nurturing globe amaranth during its vegetative phase (up to 60 days post-transplanting). This substitution resulted in a favorable benefit-to-cost ratio of 2.8.

4.5. Effect on micro-organisms

The practice of intercropping enhances ecosystem functions, such as grain nitrogen levels, enzyme activity and microbial biomass carbon. The intercropping system exhibited greater alpha diversity in bacteria and fungi. Additionally, the urease activities were significantly elevated in the intercropping system compared to monocropping.

Tuberose, gerbera and marigold were grown as intercrop in coconut plantation. The highest average coconut nut yield was observed in the coconut + gerbera treatment. Coconut + tuberose treatment recorded the maximum population of fungi, while coconut + marigold had the highest population of actinomycetes and maximum population of bacteria. In terms of soil NPK content, coconut + gerbera treatment yielded superior results. However, the rhizosphere soil in the coconut + tuberose treatment displayed the highest colony- forming unit (cfu) count for both actinomycetes and bacteria compared to the other treatments (Mondal *et al*., 2021).

In a pot experiment aimed at examining the impact of grape seedlings intercropped with post-grafting generations of *Impatiens balsamina* on various cadmium (Cd) fractions in soil, notable findings emerged. Result showed that a notable upsurge of 52% in residual Cd content and a simultaneous increase of 19% in exchangeable Cd content were observed. To sum up, despite some intercropping treatments causing an increase in residual Cd, it was concluded that grape seedlings were not suitable for intercropping with post-grafting generations of *Impatiens balsamina* (Zhong *et al*., 2018).

5. Role of crop improvement in intercropping

As intercropping becomes increasingly prevalent, there is a growing demand for cultivars that are well-suited to these cropping systems. The design of a breeding scheme should incorporate details regarding species variation concerning performance in intercropping, as well as the presence of genotype X management interaction. Goals for breeding flowers for intercropping include enhancing quality, fostering variation, increasing flower yield, bolstering resistance to biotic factors and fortifying resilience against abiotic stresses.

A research study was conducted to assess the performance of twenty-three varieties of heliconia within a twenty-year-old coconut plantation with a spacing of 1.5x1.5m so has to accommodate 25 plants in 4 coconut plants. The earliest flowering was noticed in heliconia type Choconiana (124 days) and Sexy Pink took 445 days for first flowering. Number of flowering suckers per clump was highest in Bihai (15) followed by Lobster Claw Two (13). Spike length was highest in Sexy Pink (108.15 cm) indicating its potential as cut flower followed by Kenya Red (67.83 cm) and St. Vincent Red (66.41 cm) (Thangam *et al*., 2014).

Introducing crop plants from their place of origin or established cultivation to regions where they have not previously been grown. Grand gala and Passion are the varieties of rose introduced to India.

Selection is the method that supports the survival and subsequent proliferation of certain plants possessing more favourable traits compared to others. Examples: Chrysanthemum varieties include Apsara, Birbal Sahani, Jayanthi, and Kundan. China aster varieties such as Kamini, Poornima, Shashank, and Violet Cushion have been developed through pedigree selection.

Hybridization refers to the process of mating or crossing two plants or lines with differing genotypes. Examples: Gladiolus varieties include Meera (G.P.1 X Friendship), Nazrana (Black Jack X Friendship), Apsara (Black Jack X Friendship). Marigold varieties such as Arka Honey, Arka Pari.

Mutation denotes the abrupt heritable alteration in a trait of an organism. Examples: Chrysanthemum varieties like Kasturba Gandhi derived from Mahatma Gandhi, Sonar Bangla derived from Snowball, White Cloud derived from Pink Cloud, Sharad Shobha derived from Sharada. Gladiolus varieties such as Shobha induced by gamma rays. Rose varieties like Pusa Chrystiana, Abhisarika, Madhosh, Angara.

6. Disadvantages of intercropping

I. Yield diminishes due to variations in the competitive abilities of different crops.
II. Managing intercropping proves challenging due to the necessity for different cultural practices.
III. The utilization of improved implements becomes impractical.
IV. Optimal use of higher amounts of fertilizer or irrigation water becomes problematic.
V. Harvesting presents difficulties.

7. CONCLUSION

Intercropping stands out as a highly effective method within cropping systems, enhancing the quality of various flower crops and boosting farm income. Additionally, it generates increased employment opportunities for farming families. By fostering a congenial microclimate within the main field, intercropping contributes to heightened production of the primary crop. This approach optimizes the utilization of resources, leading to greater efficiency. Notably, intercropping has significantly bolstered flower production and productivity per unit of land across India, proving highly advantageous for farmers. Moreover, it plays a role in maintaining soil fertility, mitigating soil erosion, optimizing space utilization and effectively managing pests and weeds.

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