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Assessment of system productivity and profitability of tomato based intercropping systems under South Gujarat condition

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Abstract

Tomato (*Solanum lycopersicum* L.) is one of the important vegetable crop and source of income for small and marginal farmers. Intercropping with short duration leafy vegetables is an effective approach to enhance system productivity, resource use efficiency and farm profitability. Based on this, the performance of tomato based leafy vegetable intercropping systems experiment was conducted during the *rabi* seasons, 2023-24 and 2024-25 at the Wheat Research Station, Navsari Agricultural University, Bardoli, Gujarat. It was laid out in a Randomized Block Design (RBD) with ten treatments and three replications. The treatments consisted of sole tomato at two spacings (90 or 120 × 45 cm) and tomato intercropped with either coriander, fenugreek, palak or kale in 1:2 and 1:3 rows proportion. The results indicated that tomato + kale (1:3) recorded the significantly higher tomato yield (31.68 t ha⁻¹), tomato equivalent yield (45.04 t ha⁻¹). It was statistically at par with tomato + palak (1:3) for tomato yield (29.64 t ha⁻¹) and tomato equivalent yield (42.72 t ha⁻¹). However, the maximum cost of cultivation (₹ 3, 42, 653 ha⁻¹) and gross returns (₹ 4,50,400 ha⁻¹) were noted under treatment tomato + kale (1:3), while net returns (₹ 2,08,398 ha⁻¹) and benefit: cost ratio (1.95) were obtained higher with tomato + palak (1:3). In view of the above facts, it may be concluded that tomato + kale (1:3) is more productive in terms of tomato yield, equivalent yield and gross returns, whereas tomato + palak (1:3) is high profitable intercropping system due to better net returns and benefit: cost ratio.

Keywords: Tomato, leafy vegetable, intercropping, tomato equivalent yield

Introduction

Tomato (*Solanum lycopersicum* L.) is herbaceous plant which belongs to family Solanaceae. Tomatoes are native to northwestern South America and widely cultivated for its fleshy fruit. Tomato fruit consumed as raw or vegetable. It is major used in the preparation of soup, ketchup, puree, preserve, sauce, paste, powder, pickle, drink and as dried. It is a highly nutritious vegetable along with medicinal properties. Fruit is rich source of carbohydrates, sugars, dietary fibre, fat, proteins, organic acids, vitamin A, C and E as well as minerals. The fruit is also rich in lycopene, a powerful natural antioxidant and responsible for red colour. It is considered to be a very good appetizer, promoter of gastric secretion, blood purifier, an intestinal antiseptic and reduces cardiovascular risks, valued for its anti-cancer property (Singh and Sharma, 2017) [5].

Although, it is a profitable crop, sole cultivation often results in underutilization of land, labour and other production resources during the early stages of crop growth. Intercropping offers an effective approach for improve land use efficiency, productivity and farmers' income. Short-duration leafy vegetables are suitable as intercrops in tomato because of their rapid growth, shallow root and early maturity allowing them to complete their life cycle before tomato crop reach peak nutrient demand. In addition, leafy vegetables provides early income, suppress weeds, improve resources utilization and contributes to sustainable crop production.

Among leafy vegetables, coriander, fenugreek, palak and kale possess desirable characteristics for intercropping with tomato due to their non-competitive growth habits and high market demand.

Despite the widespread practice of tomato intercropping by farmers, scientific information on suitable leafy vegetable intercrops and optimum row proportions under the agro-climatic condition of South Gujarat is limited. Therefore, the present investigation entitled assessment of yield, system productivity and profitability of tomato based intercropping systems under South Gujarat condition was conducted.

Materials and Methods

The present investigation was conducted at the Wheat Research Station, Navsari Agricultural University, Bardoli, during the years 2023-24 and 2024-25. Ten treatments comprising tomato based leafy vegetables intercropping systems, viz., sole tomato at 90 cm × 45 cm (T₁), tomato + coriander (1:2) (T₂), tomato + fenugreek (1:2) (T₃), tomato + palak (1:2) (T₄), tomato + kale (1:2) (T₅), sole tomato at 120 cm × 45 cm (T₆), tomato + coriander (1:3) (T₇), tomato + fenugreek (1:3) (T₈), tomato + palak (1:3) (T₉) and tomato + kale (1:3) (T₁₀) were evaluated in a Randomized Block Design with three replications. Tomato (cv. Gujarat Tomato 7) was grown as the main crop and intercropped with coriander (cv. GDLC 1), fenugreek (cv. Pusa Early Bunching), palak (cv. Pusa Bharati) and kale (cv. Pusa Kale 64).

Farmyard manure @ 25 t ha⁻¹ was uniformly incorporated into the soil on a dry weight basis during land preparation. The recommended dose of fertilizers (100: 50: 50 NPK kg ha⁻¹) was applied to tomato. A basal application of 50% N and K and full dose of P was applied through urea, muriate of potash (MOP) and diammonium phosphate (DAP), respectively at the time of transplanting. The remaining 50% N and K were applied in two equal splits at 30 and 50 DATP. The fertilizer requirement for each intercrop was

calculated based on RDF and the plant population per unit area of the respective treatments. Accordingly, half of nitrogen along with full of phosphorus and potassium were applied as a basal dose at sowing or transplanting by using urea, DAP and MOP, respectively. The remaining half of nitrogen was applied as a top dressing after 30 days. Healthy tomato and kale seedlings were treated with carbendazim @ 2 g L⁻¹ water for 10-15 minutes and transplanted on 6th November, 2023 and 14th November, 2024. Tomato was planted at 90 × 45 cm (T₁₋₅) and 120 × 45 cm (T₆₋₁₀), while intercrops kale transplanted at 30 × 15 cm, coriander, fenugreek or palak were directly sown at 30 × 7.5 cm as per the respective treatments.

Total 10 in 2023-24 and 11 in 2024-25 irrigations were applied by the first irrigation immediately after transplanting or sowing of crops. Weeding was done through one digging at 30 DAS followed by a hand weeding at 60 DAS. Tomato plants were staked by using bamboo poles for vertical support with threads.

Tomato fruits were manually harvested at marketable maturity at regular intervals from 6th January to 10th March, 2024 and 15th January to 16th March, 2025. Intercrops were also harvested manually at their respective maturity stages from 5th December, 2023 to 15th January, 2024 and 14th December, 2024 to 21st January, 2025. Data on yield and yield contributing characters were taken and analysed statistically. The tomato equivalent yield of intercropping systems was calculated by takes into account the green yield of component crop and prevailing market price of both main crop and intercrops added in to tomato fruit yield of respective treatment. The TEY was calculated by using the following formula:

$$\text{TEY (t ha}^{-1}\text{)} = \frac{\text{Fruit yield of tomato (t ha}^{-1}\text{)}}{\text{Yield of intercrop (t ha}^{-1}\text{)}} + \frac{\text{Yield of intercrop (t ha}^{-1}\text{)} \times \text{Market price of intercrop (₹ t}^{-1}\text{)}}{\text{Market price of tomato (₹ t}^{-1}\text{)}}$$

Results and Discussion

Yield of Main Crop and Intercrops

The yield of tomato and intercrops were presented in Table 1. The marketable fruit yield of tomato was recorded significantly higher under tomato + kale (1:3 row ratio) with a value of 31.68 t ha⁻¹ as compared to other treatments. It was statistically at par with tomato + kale; 1:2 rows (30.75 t ha⁻¹), tomato + coriander; 1:3 rows (29.75 t ha⁻¹), tomato + palak; 1:3 rows (29.64 t ha⁻¹) and tomato + palak; 1:2 rows (29.03 t ha⁻¹). The significant low marketable fruit yield (24.09 t ha⁻¹) of tomato was recorded under sole tomato (90 × 45 cm). The N and P play vital roles in physiological and biochemical processes, photosynthesis, translocation of photosynthates and energy transfer, thereby enhancing yield. Overall, tomato + kale (1:3) performed best for yield, which may be attributed to better nutrient availability, improved light interception, photosynthesis and reduced competition for water and nutrients (Soniya *et al.*, 2021a) [7].

The significantly higher total green yield of leafy vegetables was recorded under tomato + palak (1:3) with 8.72 t ha⁻¹ yield of palak. The treatment tomato + palak (1:2) lagged behind at par to them for total green yield (7.79 t ha⁻¹) of palak. Whereas, poorer total green yield (5.33 t ha⁻¹) of kale noted by tomato + kale (1:2). The variation in green yield of leafy intercrops may be attributed to differences in genetic growth potential, plant population, leaf size and biomass accumulation. Higher plant density and greater biomass production in palak and fenugreek resulted in higher green yield, whereas slower establishment and longer crop duration of kale limit its yield. Wider tomato row spacing (120 cm) may have further improved light interception and reduced competition, favouring intercrop productivity. Khati *et al.* (2026) [4] and Chaudhari *et al.* (2022) [3] also reported higher green yield and biomass production in leafy (fenugreek) vegetable intercrops.

Table 1: Effect of tomato based leafy vegetable intercropping on tomato marketable yield, intercrop green yield and tomato equivalent yield (t ha⁻¹).

Treatments			Marketable fruit yield of tomato (t ha ⁻¹)	Total green yield of intercrops (t ha ⁻¹)	Tomato equivalent yield (t ha ⁻¹)	% increase of TEY over T ₁
T ₁	:	Tomato sole crop (90 cm x 45 cm)	24.09 ^f	-	24.07 ^e	-
T ₂	:	Tomato + Coriander (1:2)	28.06 ^{bcd}	6.05 ^{de}	37.13 ^e	54.3
T ₃	:	Tomato + Fenugreek (1:2)	25.15 ^{ef}	5.60 ^{ef}	33.56 ^d	39.43
T ₄	:	Tomato + Palak (1:2)	29.03 ^{abcd}	7.79 ^b	40.72 ^b	69.17
T ₅	:	Tomato + Kale (1:2)	30.75 ^{ab}	5.33 ^f	41.40 ^b	71.99
T ₆	:	Tomato sole crop (120 x 45 cm)	26.28 ^{def}	-	26.28 ^e	9.18
T ₇	:	Tomato + Coriander (1:3)	29.75 ^{abc}	7.31 ^{bc}	40.72 ^b	69.17
T ₈	:	Tomato + Fenugreek (1:3)	27.75 ^{edc}	6.53 ^d	37.54 ^e	55.95
T ₉	:	Tomato + Palak (1:3)	29.64 ^{abc}	8.72 ^a	42.72 ^{ab}	77.49
T ₁₀	:	Tomato + Kale (1:3)	31.68 ^a	6.68 ^{cd}	45.04 ^a	87.12
S.Em.±			0.89	0.22	1.00	-
C.D. at 5%			2.55	0.65	2.86	-
CV. (%)			7.71	8.09	6.61	-

^a Mean values followed by the same letter in a column are not statistically different (DNMRT).

System Productivity

The productivity of various intercrops computed in terms of tomato equivalent yield, was furnished in Table 1. The tomato equivalent yield (TEY) was significantly influenced by the intercropping systems. The high TEY (45.04 t ha⁻¹) was recorded under tomato + kale (1:3), followed by tomato + palak; 1:3 rows (42.72 t ha⁻¹), whereas lower was cited under sole tomato; 90 × 45 cm planting (24.07 t ha⁻¹). Accordingly, the maximum increase in TEY over T₁

(87.12%) was observed in T₁₀, followed by T₉ (77.49%) and T₅ (71.99%). The higher equivalent yield under tomato + kale (1:3) may be attributed to better resource use, reduced competition, improved light interception and higher combined yield of tomato and intercrop, along with the high market value of particular leafy intercrop. Similar higher tomato equivalent yield in intercropping systems was reported by Abd El-Gaid *et al.* (2014) ^[1] and Soniya *et al.* (2021b) ^[7] in tomato.

Table 2: Effect of tomato based leafy vegetables intercropping systems on economics

Treatments			Cost of cultivation (₹ ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B:C ratio
T ₁	:	Tomato sole crop (90 cm x 45 cm)	197307	240900	43593	1.22
T ₂	:	Tomato + Coriander (1:2)	221963	371350	149387	1.67
T ₃	:	Tomato + Fenugreek (1:2)	213938	335500	121562	1.57
T ₄	:	Tomato + Palak (1:2)	227272	407150	179878	1.79
T ₅	:	Tomato + Kale (1:2)	334631	414100	79469	1.24
T ₆	:	Tomato sole crop (120 x 45 cm)	189290	262800	73510	1.39
T ₇	:	Tomato + Coriander (1:3)	217608	407150	189542	1.87
T ₈	:	Tomato + Fenugreek (1:3)	212721	375450	162729	1.76
T ₉	:	Tomato + Palak (1:3)	218802	427200	208398	1.95
T ₁₀	:	Tomato + Kale (1:3)	342653	450400	107747	1.31

Economics of Intercropping

The economics on various treatments in tomato based intercropping system was computed and furnished in Table 2. Among the treatments, tomato + kale (1:3) recorded the higher gross returns of ₹ 4,50,400 ha⁻¹ and it trailed by treatment tomato + palak (1:3) recorded gross returns of ₹ 4,27,200 ha⁻¹. Whereas, the cost of cultivation noted higher ₹ 3,42, 653 ha⁻¹ under tomato + kale (1:3). While, minimum gross returns obtained from sole tomato (90 × 45 cm) in terms of ₹ 2,40,900 ha⁻¹ and cost of cultivation by sole tomato (120 x 45 cm) expensed ₹ 1,89, 290 ha⁻¹. While, the maximum net returns of ₹ 2,08,398 ha⁻¹ recorded under tomato + palak (1:3) and minimum ₹ 43,593 ha⁻¹ with sole tomato (90 × 45 cm). The B: C ratio was recorded higher (1.95) under tomato + palak (1:3) and minimum (1.22) by sole tomato (90 × 45 cm). The economic advantage of tomato based intercropping was mainly determined by the combined yield and market value of tomato and intercrops. Although tomato + kale (1:3) recorded higher gross returns, its higher cultivation cost reduced net profitability. In divergence, tomato + palak (1:3) achieved higher net returns and B: C ratio due to comparatively low cultivation cost, makes it more profitable intercropping system. Similar

economic benefits of intercropping were reported by Akhtar *et al.* (2021) ^[2] and Yasmine and Papadopoulos (2025) ^[8] in tomato.

Conclusion

In view of the above facts, it may be concluded that intercropping of tomato with kale in a 1:3 rows ratio has more productive system for achieving higher tomato yield and tomato equivalent yield with gross returns. However, intercropping tomato with palak in a 1:3 rows ratio proved better profitable system by recording the higher net returns with benefit: cost ratio.

References

1. Abd El-Gaid MA, Al-Dokeshy MH, Nassef DMT. Effects of intercropping system of tomato and common bean on growth, yield components and land equivalent ratio in New Valley Governorate. Asian Journal of Crop Science. 2014;6(3):254-261.
2. Akhtar W, Anwar MZ, Taj S, Afridi GS, Palanappian G, Khan MZU. Economic evaluation of tomato sole and tomato-onion intercropping systems of smallholders in

- District Muzaffargarh, Pakistan. Biological Life and Environmental Sciences. 2021;58(2):99-105.
3. Chaudhari SD, Desai LJ, Chaudhary HN. Feasibility of leafy coriander and leafy fenugreek as intercrop in cumin (*Cuminum cyminum* L.). The Pharma Innovation Journal. 2022;11(6):1515-1519.
 4. Khati M, Samnotra RK, Kumar S. Growth performance of cauliflower under short-duration vegetable intercropping. Plant Archives. 2026;26(1):2171-2176.
 5. Singh AV, Sharma SK. Response of tomato (*Solanum lycopersicum* L.) to fertigation by irrigation scheduling in drip irrigation system. Journal of Applied and Natural Science. 2017;9(2):1170-1175.
 6. Soniya T, Kamalakannan S, Maheswari TU, Sudhagar R, Kumar S. Effect of intercropping on yield, system production efficiency and economics of tomato (*Solanum lycopersicum*). Crop Research. 2021b;56(1-2):23-29.
 7. Soniya T, Kamalakannan S, Maheswari TU, Sudhagar R. Effect of intercropping on growth and yield of tomato (*Solanum lycopersicum* L.). Annals of Plant and Soil Research. 2021a;23(1):36-41.
 8. Yasmine A, Papadopoulos N. Agronomic and economic performance of basil and tomato of intercropped Mediterranean environments. Australian Journal of Global Horticulture and Agronomy Science. 2025;2(2):19-26.