**EVALUATION OF FIG (*FICUS CARICA* L.) CULTIVARS FOR FERTIGATION RESPONSE IN BREBA CROP YIELD AND QUALITY IN THE NORTHERN TELANGANA ZONE**

**ABSTRACT**

Fig (*Ficus carica* L.) is a profitable arid crop and responds well to irrigation. A field experiment was conducted at Horticultural Research Station, Adilabad with three different fig cultivars (Brown Turkey, Deanna and Poona Red) as main plots and irrigation methods (rainfed, drip irrigation and fertigation schedules adjusted to growth stages as in Biologische Bundesanstalt, Bundessortenamt and Chemische Industrie (BBCH) numerical scale) as subplots arranged in the Factorial Randomized Block Design during the year 2023-24. The objectives were to study the effects of micro-irrigation and fertigation responses of Brown Turkey, Deanna and Poona Red on breba crop fruit yield and quality and to advise the farmers on selection of variety, water management and fertilization practices.Results revealed that fertigation significantly enhanced vegetative and yield traits across all varieties. The Deanna cultivar under fertigation (V2I2) recorded the highest fruit yield (4.13 kg/tree), fruit weight (78.55 g), and diameter (52.92 mm), along with quality parameters such as TSS (19.67 °Brix), reducing sugars (15.14%) and flavour index (109.27). Brown Turkey showed moderate performance in terms of yield (2.84 kg/tree) and quality traits, while Poona Red under rainfed conditions (V3I0) recorded the lowest yield (2.05 kg/tree) and quality attributes, including the lowest fruit diameter (23.69 mm) and higher titratable acidity (0.34%). Fertigation significantly improved nutrient use efficiency and water availability, contributing to better growth and fruit development. The findings demonstrate that cultivar × irrigation interaction plays a crucial role in determining fig productivity and quality, with all varities under fertigation emerging as profitable for farming community under Northern Telangana zone.

*(Keywords: Fig cultivars, BBCH growth stages, Fertigation schedules, Breba crop yield, Fruit quality)*

1. **INTRODUCTION**

 The fig tree (*Ficus carica* L.) is unique in its ability to potentially produce one or more crops of fruit annually (Marcotuli *et al* 2020). The number of crops distinguishes the varieties as either uniferous (main crop only), biferous (breba and main crop), or triferous (breba, main crop, and autumn crop). Fruiting on the past season growth is called breba, which ripening in April-May with fruits generally larger than the main crop and persistent. The second crop is the main crop with a possible third crop less harvested in autumn in few cultivars (Ferrara *et al*., 2017; Marcotuli *et al*., 2019).Among fruit trees, fig trees can withstand drought and thrive in saline-sodic soils (Abdolahipour *et al*., 2019). The consumption of figs constitutes an important source of polyphenolic antioxidants, anthocyanins (aglycone 99-85%), and cholesterolfree fats, among other compounds (Ercisli *et al.,* 2012).The early timing of the Breba harvest can be advantageous, especially in regions where the growing season is relatively short, as it allows growers to obtain a yield before the main crop matures. However, the decision to focus on maximizing the Breba crop requires careful consideration of potential trade-offs, as resources allocated to the early crop might influence the subsequent main crop and the overall vigor of the tree. In some instances, growers may even opt to suppress the Breba crop to direct the plant's energy towards producing a larger and good quality main crop.

Fertigation, a technique that involves delivering water-soluble fertilizers directly to the root zone through an irrigation system, offers a precise method for managing nutrient supply to fruit trees.Drip fertigation can reduce fertilizer use by 25-40% (Shirgure, 2001. Hasan *et al.,* 2007; Thakur *et al*., 2012) and increase fertilizer use efficiency (Ranghaswami *et al.,* 2006; Sharma *et al*., 2018). It can also save time and labor (50-60%), water (50-60%), and increase yield (12-76%) and water use efficiency (70-95%) (Mellado *et al*., 2005; Hasan *et al.,* 2007 Nosir, 2023).This approach can potentially enhance nutrient uptake efficiency, minimize losses, and allow for more frequent applications that closely match the plant's changing needs throughout its growth cycle. Research suggests that a balanced supply of macronutrients, particularly nitrogen, is important for overall fig growth and production. Fig yield depends on the balance between vegetative growth and fruiting.

For young trees, an application of fertilizer in early spring is often recommended to support vegetative growth. Some sources suggest that during the initial dormancy break, a fertilizer higher in nitrogen might be beneficial, followed by a more balanced or lower nitrogen formula to encourage fruiting. However, excessive nitrogen, especially after fruit set, is generally discouraged as it can lead to excessive leaf growth and reduced fruit quality. While figs respond well to nitrogen fertilization, over-fertilization can delay ripening and negatively impact the quality of the fruit. Other macronutrients such as calcium and magnesium are also recognized as essential for fig health and fruit development. Calcium plays a crucial role in cell wall structure and fruit firmness, while magnesium is vital for chlorophyll production and photosynthesis.

Fertigation, the application of fertilizers through irrigation systems, has emerged as a pivotal technique in modern horticulture, enhancing nutrient use efficiency and crop productivity. In fig cultivation, particularly for the breba crop which develops on the previous year's shoot growth and ripens in spring understanding the response of different cultivars to fertigation is essential for optimizing yield and fruit quality. Organic fertilizers, such as farmyard manure, can improve soil structure and provide a slow release of essential nutrients. Potassium fertilization has been shown to help figs tolerate water stress,(Holstein *et al.*2015),which could be particularly beneficial in the semi-arid climate of Adilabad. By delivering these nutrients directly to the root zone via the drip irrigation system, fertigation can enhance nutrient uptake efficiency and allow for more precise control over the timing and amounts of fertilizers applied, potentially leading to improved breba crop yield. The objectives of this study were to evaluate the effects of micro-irrigation and fertigation on the breba crop fruit yield and quality of Brown Turkey, Deanna and Poona Red cultivars, and to provide recommendations for farmers on variety selection, water management and fertilization practices.

1. **MATERIALS AND METHODS**

**Planting materials**

Semi-hard wood cuttings of the Poona Red, Deanna and Brown Turkey fig cultivars were obtained from fig orchards in the Adilabad, Wanaparty and Gadwal districts of Telangana State in July 2023. A brief description of these cultivars is furnished in Table 1. The cuttings were pre-treated with NAA 1000 ppm in flash dip method and kept for rooting in red earth and vermicompost media (1: 1 ratio) on raised beds for 60 days in primary nursery at Horticultural Research Station, Adilabad.

**Table1.Comparison of morphological and pomological characteristics of Fig Varieties**

|  |  |  |  |
| --- | --- | --- | --- |
| **Characters** | **Brown Turkey** | **Deanna** | **Poona Red** |
| **Branching pattern** | Semi spreading | Erect and dichotomous | Spreading type |
| **Leaf size, shape and number lobes** | Medium palmate leaf with 5 lobes | Large, palmate with 5to 6 lobes | Large, palmate with fused lobes |
| **Leaf colour** | Dark green | Dark green | Light green |
| **Fruit bearing** | Biferous | Biferous | Biferous |
| **Resistance to fruit cracking** | Very High | Low | Moderate |
| **Ease of peeling skin** | Very easy | Easy | Difficult |
| **Skin colour** | Deep purple to brown | Greenish to light yellow | Red to purple skin |
| **Flesh colour** | Light red colour | Lemon yellow to white | Dark red flesh |
| **Seed density per fruit** | Medium | High | Less |

**2.2 Planting and Experimental Design**

Uniformly rooted cuttings of Poona Red, Deanna and Brown Turkey were transplanted in the main field at a spacing of 4 m x 2.5 m (1000 plants ha-1) during October 2023in the previously dug-out 60 cm3 pits at the Horticultural Research Station, Dasnapur, Adilabad district (Latitude 19.6480 ⁰N Longitude 78.5321 ⁰ E, elevation of 257 m above MSL), Telangana state. The varieties are arranged as main plots (V1: Poona Red, V2: Deanna and V3: Brown Turkey planted 15 trees of each cultivar) and irrigation methods (I0: Rainfed with Supplemental drip Irrigation, I1: Drip irrigation and I2: Drip irrigation with Fertigation) as sub-plots in a randomized block design with factorial concept and were replicated four times. A total of 180 trees were included in the study. The soil type of the experimental site is clay loam with pH: 8.2, Electrical conductivity: 3.1 dSm–1, Organic Carbon 0.4%, and available nitrogen, phosphorus and potassium were 25, 18.2 and 44.1 kg acre–1 respectively.

**2.3 Irrigation and Fertilizer applications**

All the plants received organic manures 15 kg Farm Yard Manure (FYM), Neem cake: 2.25 kg as basal dose mixed with soil prior to planting. The starter dose of N, P, K: 140 g, 80 g, 90 g applied from the sources Ammonium Sulphate , Single Super Phosphate, and Muriate of Potash respectively. Plants were irrigated through drip system with emitters adjusted to 4 L h-1 during the establishment stage. During the monsoon months, drip operation was adjusted daily to account for erratic rainfall. When daily rainfall exceeded 10 mm, drip irrigation was suspended for 4 to 5 days in I1 and I2 plots. In I0 plots, drip irrigation was completely suspended during the active monsoon period. In I2 plots, fertigation schedule adjusted to phenological growth stagesin Biologische Bundesanstalt, Bundessortenamt and Chemische Industrie (BBCH) numerical scale as previously described (Akatha singh *et al*2023). The NPK and Ca applied with fertigation per plant was 62g, 46 g, 110 g and 4.7 g respectively (Table 2). In I0 and I1 similar quantities were applied at the beginning of vegetative bud development (Growth Stage 0).

**Table 2. Fertigation schedules adjusted to growth stages during the breba crop period of**

**2024**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BBCH Code** | **Description** | **Product** | **Quantity** **(kg/acre)** | **No. of applications** | **N** | **P2O5** | **K2O** | **Ca** |
|  **Growth Stage 0: Vegetative bud development** **(25/12/2023 to 15/01/2024) : 21 days** |
| 01&05 | Beginning of bud swelling to Beginning of bud elongation | 27:14:08 | 15 | 3 | 4.05 | 2.1 | 1.2 |  |
| 07& 09 | Advance bud elongation to Beginning of budbreak | 27:14:08 | 10 | 1 | 2.7 | 1.4 | 0.8 |  |
|  |  | Calcium Ammonium Nitrate | 5 | 1 | 0.775 |  |  | 0.94 |  |
| **Growth Stage 1: Leaf development (16/01/2024 to 29/02/2024): 44 days** |
| 11 & 15 | Separation of leaves to Leaf development continues | Urea | 25 | 2 | 11.5 |  |  |  |
| 17&19 | Advance leaf development to All leaves unfolded | 20:17:17 | 10 | 1 | 2 | 1.7 | 1.7 |  |
|  |  | Calcium Ammonium Nitrate | 5 | 1 | 0.775 |  |  | 0.94 |
| **Growth Stage 3: Shoot Development (01/03/2024 to 15/03/2024): 15 days** |
| 31& 33 | Beginning of shoot elongation to Advance shoot elongation | 10:08:30 | 20 | 3 | 2 | 1.6 | 6 |  |
| 37 &39 | Shoots about 70% of final length to Shoots about 90% of final length | 10:08:30 | 20 | 3 | 2 | 1.6 | 6 |  |
| **Growth Stage 5: Flower bud development(16/03/2024 to 31/03/2024): 16 days** |
| 51 & 53 | Emergence of reproductive bud &Beginning of bud elongation | 20:17:17 | 15 | 3 | 3 | 2.55 | 2.55 |  |
| 55& 59 | Initiation of Syconium development to Maturation of inflorescence bud | 20:17:17 | 5 | 1 | 1 | 0.85 | 0.85 |  |
| **Growth Stage 6: Flower bud growth(01/04/2024 to 15/04/2024): 15 days** |
| 61& 65 | Beginning of flower maturation &Peak flowering | 10:08:30 | 20 | 3 | 2 | 1.6 | 6 |  |
| 69 | End of flower maturation | 10:8:30 | 10 | 2 | 1 | 0.8 | 3 |  |
| **Growth Stage 7: Syconium Development (16/04/2024 to 30/04/2024): 15 days** |
| 71 &75 | Fruit set & Syconium at 50% of final size | 10:8:30 | 10 | 2 | 1 | 0.8 | 3 |  |
| 79 | Syconium at 70% or more of final size | 10:8:30 | 30 | 5 | 3 | 2.4 | 9 |  |
| **Growth Stage 8: Syconium Maturity (01/05/2024 to 10/06/2024): 40 days** |
| 81 &85 | Beginning of Syconium maturation &Advance colour development | 10:8:30 | 1 | 2 | 1 | 0.8 | 4 |  |
| 87 & 89 | Syconium ripen ostiole opening |  |  |  |  |  |  |  |
|  | Total |  |  | 33 | 24.75 | 18.2 | 44.1 | 1.88 |

**2.4 Growth parameters**

The plant height (m) of the five trees in each subplot were measured from the ground level to top of the main branch with the help of a scale after the end of breba crop harvest. The total number of primary and secondary branches was counted for each tree and the average of fivetrees was expressed as treatment means. The total number of leaves per branch was counted for each tree and the average of the five trees expressed as treatment mean.

**2.5 Pomological parameters**

Fruit diameter and individual fruit weights were measured with digital vernier caliper and weighing scale respectively. The numbers of fruits harvested from each treatment were recorded. The average weight of 10 fruits was recorded and multiplied with number of fruits harvested during the breba crop period and yield was expressed as kilogram per tree. The total soluble solids (TSS) content of the pulp was measured using a handheld Brix refractometer (RHB-32ATC, Erma Tokyo, Japan) at room temperature and expressed in °Brix. TSS percent was calculated by multiplying the direct reading from the instrument by 100**.**Titratable acidity (TA) was estimated by the juice of white pulp and titrated against 0.1 N NaOH till a light pink colour as the endpoint (Hortwitz W 2000). The flavor index of the fruits expressed as the ratio of soluble solids to the Titratable Acidity.

Reducing sugars in fig pulp were estimated by the Lane and Eynon method (AOAC, 2006). Ten grams of pulp was treated with 22% lead acetate and kept for 3 hours for precipitation, followed by de-leading with 45% potassium oxalate. The filtrate was titrated with Fehling’s A and B solutions using methylene blue as an indicator. Non-reducing sugars were calculated by subtracting reducing sugars from total sugars.Ascorbic acid content was estimated by titrating the pulp extract (prepared in 3% metaphosphoric acid) against 2,6-dichlorophenol indophenol dye and expressed as mg per 100 g of pulp.(Rao *et al*.1987).

**2.6 STATISTICAL ANALYSIS**

Data collected on various quantitative growth parameters were statistically analyzed using SAS 9.4 software (SAS Institute Inc., Cary, NC, USA). The univariate procedure was used to test the assumptions of normality and homogeneity of variance for ANOVA using normal P-P and Q-Q plots. The General Linear Model (GLM) procedure was used to compare the genotypes for the parameters measured in this study. Post-hoc pairwise comparisons of treatment means were conducted using Tukey's HSD test at α = 0.05 when ANOVA indicated significant differences (P≤ 0.05).

**3.0 RESULTS AND DISCUSSION**

The breba crop in fig trees represents the first harvest of the growing season, a phenomenon that occurs in a select number of fig varieties.These early figs develop from dormant fruit buds that formed on the mature wood of the previous year's growth, typically ripening in the spring or early summer, well in advance of the main fig crop. This early production is a significant advantage for fig growers, particularly in regions where the growing season might be limited, as it provides an opportunity for fruit harvest even if the subsequent main crop faces challenges. However, the ability to produce a reliable breba crop is not a universal trait among fig varieties; it is estimated that only about 15% of fig cultivars possess this characteristic to a dependable degree. The ripening period for breba figs is generally shorter compared to the main crop, typically lasting between 5 and 15 days, whereas the main crop usually ripens over a more extended period of 30 to 60 days.

The F-statistics and *P*-values in the ANOVA tables (Tables 3, 4 and 7) indicated that irrigation methods, particularly fertigation and fig varieties significantly affected fruit yield and quality parameters.Significant variation was observed among the treatments. The maximum yield was recorded for the Deanna cultivar under fertigation (V2I2), with 3.86 kg/tree and a fruit weight of 53.80 g. Although TSS levels were slightly reduced under fertigation compared to rainfed irrigation (17.16 °Brix and 20.81 °Brix), the overall yield and quality benefits were substantial.

These differences can be attributed to improved nutrient uptake efficiency and fertilization under fertigation, which is supported by better vegetative growth and reproductive success. The improved distribution of assimilates from the artificial application of nutrients through drip systems likely promoted cell division and enlargement, resulting in larger fruit sizes.Such observations align with previous reports on mango and guava (Devi *et al*., 2023; Kumawat *et al.,* 2019), and are consistent with findings in fig by Kumar *et al*. (2014) and Swathi*et al.* (2022), which reported superior performance of the Deanna cultivar under intensive nutrient management.

**Table 3 Analysis of Variance (ANOVA) of *P*-values of Irrigation methods and varieties of fig (*Ficus carica*) for vegetative parameters and yield parameters in breba crop during 2024**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Factor** | **Plant height (cm)** | **Primary branches** | **Secondary branches** | **No of leaves per branch** | **No.of fruits per tree** | **Fruit weight (g)** | **Fruit diameter (mm)** | **Yield per plant (kg)** | **TSS (°Brix)** | **Reducing sugars (%)** |  **Non Reducing sugars (%)** | **Titrable acidity (%)** | **Ascorbic acid****(mg /100g)** |
| **Variety (V)** | 0.038 | 0.00 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **Irrigation (I)** | 0.798 | 0.264 | 0.628 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **VXI** | 0.232 | 0.931 | 0.320 | 0.000 | 0.002 | 0.092 | 0.008 | 0.000 | 0.349 | 0.029 | 0.015 | 0.024 | 0.002 |

Values followed by different letters in a column are significantly different by Turkey’s HSD test at p≤0.05.

**3.1 Vegetative Growth**

A perusal of data in the growth performance of fig cultivars under different irrigation treatments showed statistically significant differences among the varieties in plant height, number of branches, and number of leaves per branch (Table 4). Poona Red recorded the highest plant height (147.34 cm), followed by Deanna (134.43 cm) and Brown Turkey (134.13 cm). However, Brown Turkey produced significantly more primary (5.13) and secondary (12.77) branches than Deanna and Poona Red. The greater vegetative growth in Poona Red may result from its vigorous growth habit and spreading architecture, whereas the increased branch proliferation in Brown Turkey reflects its semi-spreading canopy and higher node productivity. These results align with the cultivar characteristics as reported by Ferrara *et al*. (2017), where fig varieties display distinct growth habits due to their genetic diversity.

Across all cultivars, fertigation treatment (I2) increased vegetative growth, with the maximum values observed for plant height (138.67 cm), primary branches (4.34), secondary branches (8.53), and leaves per branch (44.90), although the V×I interaction was not significant for most growth traits. The improved vegetative growth under fertigation correlates the findings from mango fertigation studies by Devi *et al*. (2023), which also demonstrated improved canopy architecture and leaf density under precise nutrient delivery via drip system. Similar benefits of fertigation on canopy development have been reported in other perennial fruits like pomegranate and guava, highlighting the improved root zone nutrient availability and absorption efficiency (Kafkafi and Tarchitzky, 2011).

These findings are consistent with reports in mango by Devi *et al.* (2023), who found enhanced vegetative vigor under drip fertigation due to improved nutrient availability and uptake efficiency.

**Table 4 Main effects of Irrigation methods and varieties on growth of fig (*Ficus carica*) in breba crop during 2024.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Factor** | **Plant height (cm)** | **No. of Primary branches** | **No. of Secondary branches** | **No of leaves per branch** |
| **Variety (V)** |  |  |  |  |
| Brown Turkey | 134.13b | 5.13a | 12.77a | 41.66b |
| Deanna | 134.43b | 3.41b | 9.25b | 53.52a |
| Poona red | 147.34a | 3.30b | 7.93c | 24.44c |
| **Irrigation (I)** |  |  |  |  |
| I0 | 135.07a | 3.81a | 8.12a | 38.83c |
| I1 | 137.88a | 4.16a | 8.25a | 42.32b |
| I2 | 138.67a | 4.34a | 8.53a | 44.90a |

Varieties: V1 Brown Turkey, V2 Deanna, V3 Poona red;

Irrigations: I0:Rainfed with Supplemental drip Irrigation, I1: Drip irrigation and I2: Drip irrigation with Fertigation.Values followed by different letters in a column are significantly different by Turkey’s HSD test at *P*≤0.05.

**3.2 Pomological parameters,fruit yield and quality**

It is inferred from the datavarietal and irrigation treatments significantly influenced the chemical composition and flavour index of the fig fruits (Table 5). Among the three varieties, Deanna consistently outperformed others in terms of early bearing, total soluble solids (TSS), reducing sugars, non-reducing sugars and flavour index, indicating its superior fruit quality attributes. Specifically, Deanna recorded the highest TSS (21.65 °Brix), reducing sugars (15.23%), non-reducing sugars (2.12%), and flavour index (108.25), coupled with the lowest titratable acidity (0.20%).This previous findings by Hiwale *et al.* (2015), who reported that Deanna produces fruits with elevated TSS and enhanced sweetness, thereby offering better market value. Similar observations were made by Kumar *et al*. (2014), who attributed these superior characteristics to the cultivar's robust physiological and biochemical profile under optimal horticultural practices.

In contrast, the Brown Turkey variety exhibited the lowest TSS (16.96 °Brix), reducing sugars (12.51%), and flavour index (48.45), along with the highest titratable acidity (0.35%), indicating comparatively inferior organoleptic properties. These findings are in line with Kaul *et al.* (2018), who categorized Brown Turkey as a medium-quality cultivar with moderate physico-chemical properties. The Poona Red variety showed intermediate values, with a TSS of 19.34 °Brix and a flavour index of 65.51.

Among irrigation treatments, rainfed conditions (I₀) led to the highest TSS (20.81 °Brix) and flavour index (56.24), possibly due to concentration effects from lower fruit water content, as similarly noted in mango and guava by Devi *et al.* (2023) and Kumawat *et al.* (2019). However, this came at the cost of slightly higher titratable acidity (0.37%). Fertigation (I₂), while resulting in the lowest TSS (17.16 °Brix), maintained a moderate flavour index (71.52) and the lowest titratable acidity (0.24%), suggesting an improvement in fruit taste due to enhanced nutrient availability and uniform water distribution. This supports earlier reports by Sharma *et al.* (2020) and Patel and Meena (2021), who demonstrated the benefits of fertigation in improving overall fruit quality and reducing acidity in crops like pomegranate and papaya.

**Table 5 Main effect of Irrigation methods and varieties on quality of fig (*Ficus carica*) in breba crop during 2024.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Factor** | **TSS (°Brix)** | **Reducing sugars (%)** |  **Non Reducing sugars (%)** | **Titratable Acidity (%)** | **Ascorbic acid****(mg /100g)** | **Flavour Index****(TSS/TA)** |
| **Variety (V)** |  |  |  |  |  |  |
| Brown Turkey | 16.96c | 12.51c | 1.42b | 0.35a | 13.78a | 48.45c |
| Deanna | 21.65a | 15.23 a | 2.12a | 0.20c | 10.32c | 108.25a |
| Poona red | 19.34b | 13.36b | 1.94a | 0.29b | 9.24b | 65.51b |
| **Irrigation (I)** |  |  |  |  |  |  |
| I0 | 20.81a | 14.34a | 2.23a | 0.37a | 12.24a | 56.24b |
| I1 | 18.46b | 13.25b | 1.98b | 0.33b | 10.32b | 55.94c |
| I2 | 17.16c | 13.13b | 1.82b | 0.24c | 9.82c | 71.52a |

Varieties: V1 Brown Turkey, V2 Deanna, V3 Poona red;

Irrigations: I0:Rainfed with Supplemental drip Irrigation, I1: Drip irrigation and I2: Drip irrigation with Fertigation.Values followed by different letters in a column are significantly different by Turkey’s HSD test at *P*≤0.05.

The yield attributes of fig (*Ficus carica*) were significantly influenced by both variety and irrigation methods during the breba crop season of 2024 (Table 6). Among the varieties evaluated, Deanna demonstrated clear superiority in all measured parameters. It recorded the highest number of fruits per tree (52.73), individual fruit weight (75.32 g), fruit diameter (48.00 mm), and yield per tree (3.00 kg), confirming its potential as a high-yielding cultivar with superior fruit quality. These results are in agreement with the findings of Hiwale *et al.* (2015), who highlighted the excellent performance of Deanna in terms of fruit size and productivity. Similarly, Kumar et al. (2014) noted that Deanna responded favorably to improved agronomic practices, particularly spacing and pruning, which could further optimize its yield potential.

In contrast, Poona Red recorded the lowest yield (2.25 kg/tree), fruit weight (35.27 g), and fruit diameter (27.56 mm), along with the fewest fruits per tree (64.00), indicating its limited suitability for high-yield commercial cultivation. Brown Turkey occupied an intermediate position with a fruit weight of 40.87 g, fruit diameter of 33.24 mm, and a yield of 2.57 kg/tree. These results align with those of Kaul *et al.* (2018), who described Brown Turkey as a cultivar with moderate yield and fruit size characteristics.

Among irrigation treatments, fertigation (I₂) emerged as the most effective method, significantly enhancing all yield parameters. It resulted in the highest number of fruits per tree (80.32), fruit weight (41.48 g), fruit diameter (40.69 mm), and yield per tree (3.29 kg). These findings are from earlier studies by Sharma et al. (2020), who reported similar benefits of fertigation in pomegranate, İrget et al. (2008) in fig and Patel and Meena (2021), who found that fertigation improved fruit size and yield in papaya. The increased availability of nutrients and uniform moisture distribution under fertigation likely contributed to improved fruit set and development.

Drip irrigation (I₁) also improved yield attributes over rainfed conditions, with a yield of 2.55 kg/tree and a fruit weight of 36.95 g, indicating its positive impact on water-use efficiency and productivity. However, rainfed with supplemental drip (I₀) recorded the lowest yield (2.13 kg/tree), despite producing a moderate number of fruits per tree (61.16), suggesting that water stress may have limited fruit growth and overall yield. These findings support the conclusions of Devi *et al*. (2023) and Kumawat *et al.* (2019), who noted the adverse effects of water limitation on fruit size and yield in mango and guava.

**Table 6 Main effect of Irrigation methods and varieties on yield attributes of fig (*Ficus carica*) in breba crop during 2024.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Factor** | **No.of fruits per tree** | **Fruit weight (g)** | **Fruit diameter (mm)** | **Yield per tree (kg)** |
| **Variety (V)** |  |  |  |  |
| **Brown Turkey** | 64.14a | 40.87b | 33.24b | 2.57b |
| **Deanna** | 52.73b | 75.32a | 48.00a | 3.86a |
| **Poona red** | 64.00a | 35.27c | 27.56c | 2.25c |
| **Irrigation (I)** |  |  |  |  |
| **I0** | 61.16c | 33.83c | 33.66c | 2.13c |
| **I1** | 70.79b | 36.95b | 37.28b | 2.55b |
| **I2** | 80.32a | 41.48a | 40.69a | 3.29a |

Varieties: V1 Brown Turkey, V2 Deanna, V3 Poona red;

Irrigations: I0:Rainfed with Supplemental drip Irrigation, I1: Drip irrigation and I2: Drip irrigation with Fertigation.Values followed by different letters in a column are significantly different by Turkey’s HSD test at *P*≤0.05.

**3.3 Interaction Effects of Variety × Irrigation**

The interaction between fig varieties and irrigation methods exhibited significant variation across all measured traits during the breba crop season of 2024 (Table 8). Among the combinations, the treatment V2I2 (Deanna × Fertigation) proved superior, recording the highest performance across nearly all yield and quality attributes. It produced the highest fruit weight (78.55 g), fruit diameter (52.92 mm) and the maximum TSS (19.67 °Brix), ultimately leading to the highest fruit yield per plant (4.13 kg). In addition, this treatment also lower titrable acidity (0.18%), indicating its excellent fruit quality under fertigation. These results clearly demonstrate that fertigation significantly enhances the sink capacity and physiological efficiency of Deanna, making it an ideal variety under intensive management conditions.

Conversely, the combination V3I0(Poona Red × Rainfed) recorded the lowest productivity and fruit quality, with fruit weight of 33.22 g, fruit diameter of 23.69 mm, and a yield of just 2.05 kg per plant. It also exhibited higher titrable acidity (0.34%)indicating poor fruit taste and quality under moisture stress. This suggests that Poona Red is less adapted to rainfed conditions, possibly due to limited nutrient uptake and poor partitioning efficiency under water deficit.

The significant improvement in fig performance under fertigation treatments aligns with earlier findings by Marcotuli *et al.* (2020) and Ferrara *et al.* (2017), who observed that fig cultivars respond variably to environmental and irrigation factors. Moreover, studies by Kumar et al. (2014) emphasized the critical role of cultivar × environment interaction in enhancing productivity. Similar positive responses to fertigation were reported in mango and guava by Devi *et al.* (2023) and Kumawat *et al.* (2019), highlighting the role of precision irrigation and nutrient supply in optimizing fruit yield and quality under semi-arid conditions.

**Table 7. Interaction effects of Irrigation and varieties on vegetative parameters of Fig (*Ficus carica*) in breba crop during 2024.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Factor | **Plant height (cm)** | **No. of Primary branches** | **No. of Secondary branches** | **No of leaves per branch** |
| V1I0 | 139.67 | 5.28 | 13.67 | 39.33f |
| V1I1 | 128.11 | 4.72 | 12.67 | 41.56e |
| V1I2 | 134.61 | 5.39 | 12.00 | 44.11d |
| V2I0 | 125.13 | 3.25 | 3.00 | 47.69c |
| V2I1 | 140.27 | 3.33 | 3.27 | 54.93 b |
| V2I2 | 138.53 | 3.67 | 3.73 | 58.33 a |
| V3I0 | 143.56 | 3.56 | 8.11 | 22.11h |
| V3I1 | 151.90 | 2.90 | 7.40 | 24.80g |
| V3I2 | 146.20 | 3.50 | 8.30 | 26.20g |
| SE. m ± | 5.722 | 0.351 | 0.582 | 0.442 |
| CD at 5% | NS | NS | NS | 1.239 |
| CV% | 17.69 | 36.12 | 19.70 | 6.90 |

 Varieties: V1 Brown Turkey, V2 Deanna, V3 Poona red;

Irrigations: I0:Rainfed with Supplemental drip Irrigation, I1: Drip irrigation and I2: Drip irrigation with Fertigation.Values followed by different letters in a column are significantly different by Turkey’s HSD test at *P*≤0.05.

**Table 8. Interaction effects of Irrigation and varieties on fruit yield and quality of Fig (*Ficus carica*) in breba crop during 2024.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factor | **No.of fruits per tree** | **Fruit weight (g)** | **Fruit diameter (mm)** | **Yield per plant (kg)** | **TSS (°Brix)** | **Reducing sugars (%)** |  **Non Reducing sugars (%)** | **Titrable Acidity (%)** | **Ascorbic acid****(mg /100g)** | **Flavour Index****(TSS/TA)** |
| V1I0 | 62.72b | 39.28f | 29.59f | 2.42f | 18.83b | 12.24 | 1.42 | 0.37 | 13.24a | 50.89 |
| V1I1 | 64.06b | 40.87e | 34.18e | 2.62e | 16.89c | 12.82 | 1.34 | 0.32 | 12.45b | 52.78 |
| V1I2 | 66.40a | 42.70d | 35.97d | 2.84d | 15.83d | 11.54 | 1.22 | 0.28 | 11.32c | 56.53 |
| V2I0 | 50.81e | 72.12c | 43.86c | 3.64c | 22.44a | 16.23 | 2.13 | 0.24 | 10.23d | 93.52 |
| V2I1 | 52.70d | 75.32b | 47.36b | 3.97b | 20.47a | 16.12 | 1.98 | 0.22 | 9.87e | 93.04 |
| V2I2 | 55.50c | 78.55a | 52.92a | 4.13a | 19.67b | 15.14 | 1.87 | 0.18 | 9.22e | 109.27 |
| V3I0 | 61.67b | 33.22i | 23.69h | 2.05g | 20.89a | 13.24 | 1.95 | 0.34 | 9.82e | 61.44 |
| V3I1 | 63.50b | 35.27h | 27.74g | 2.26f | 18.90b | 12.22 | 1.89 | 0.30 | 8.72e | 63.02 |
| V3I2 | 65.60a | 38.20g | 30.89f | 2.51e | 18.20b | 12.43 | 1.76 | 0.26 | 8.12e | 70.00 |
| SE. m ± | 0.514 | 0.271 | 0.311 | 0.039 | 0.144 | 0.144 | 0.271 | 0.031 | 0.144 | 3.019 |
| CD at 5% | 1.44 | 0.758 | 0.871 | 0.110 | 0.402 | 0.402 | 0.758 | 0.073 | 0.402 | 4.742 |
| CV% | 8.137 | 4.742 | 5.478 | 9.654 | 4.965 | 2.09 | 6.454 | 5.341 | 2.09 | 8.301 |

Varieties: V1 Brown Turkey, V2 Deanna, V3 Poona red;

Irrigations: I0:Rainfed with Supplemental drip Irrigation, I1: Drip irrigation and I2: Drip irrigation with Fertigation.Values followed by different letters in a column are significantly different by Turkey’s HSD test at *P*≤0.05.

**4.0 Conclusions**

This field study highlights the significant effects of fertigation and cultivar selection on the yield and quality of the breba crop in fig under Northern Telangana agro-climatic zone. Fertigation significantly improved plant growth, including plant height, branch formation, and number of leaves per branch in all the cultivars. The Deanna cultivarresponded greatlywith the fresh fruit yield of 4.13 kg/tree with fertigation, Fertigation increased fruit yield over rainfed conditions with similar dosage of fertilizers applied at vegetative bud development stage, with fertigation overall fruit quality particularly in terms of size, appearance and marketabilitywas improved.

Disclaimer (Artificial intelligence)

Option 1:

 I Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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