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RESPONSE OF GUAVA CV. LALIT TO PLASTIC MULCH, FERTIGATION AND MICRO-NUTRIENT SPRAY UNDER RAISED BED

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Abstract: *A field experiment was carried out during the year 2017 for mrig bahar crop of guava cv. Lalit, planted in July, 2015 at spacing of 3 m x 3 m, with five treatments, viz. drip irrigation (80% pan evaporation) along with 75% recommended doses of fertiliser (RDF) (July, September and November), mulching with 100 micron UV stabilised black polyethylene and spray of micro-nutrients (zinc sulphate and boric acid @ 0.2% each) in July and August under raised bed (T_1), drip irrigation along with 75% RDF and black polyethylene mulch under raised bed (T_2), drip irrigation along with 75% RDF and micro-nutrient sprays under raised bed (T_3), drip irrigation along micro-nutrient sprays and soil application of RDF (50:25:50 g N:P:K, half N, full P and K in July and remaining N in November) under raised bed (T_4) and soil application of RDF along with basin irrigation under flat bed condition as control (T_5). Results exhibited significant increase in canopy volume, trunk-cross sectional area, average diameter of primary branches, production efficiency, and yield in T_1 (14.70 m^3, 2.99 cm^2, 2.99 cm, 40.00 fruits cm^{-2}, and 33.75 Kg $tree^{-1}$, respectively), besides ameliorating quality parameters in terms of fruit length, diameter, volume, and ascorbic acid. Though soil organic carbon and nutrient contents were non-significant, but leaf P and Fe contents were significantly higher in T_1 and T_2. Water use efficiency was significantly highest in T_1 (8.71 g l^{-1}), although water saving over control (T_5) was recorded highest in T_3 (24.77%).*
Keywords: *Guava cv. Lalit, fertiliser, irrigation, polyethylene, N, P, and K.*

Introduction: Guava (*Psidium guajava* L), the apple of tropics, is important fruit crop in India, cultivated in an area of 259 thousand hectares with annual production of 4119 thousand metric tonnes. It is the only fruit that matches the high nutritive value of more commercially important temperate fruit apple [1]. The crop has immense potential in increasing productivity and yield sustainability due to wider adaptability to varying soil and climatic conditions. However, judicious application of water and plant nutrients in guava is prerequisite to achieve the targeted yield and quality of fruits [2]. Since the crop bears fruits almost throughout the year, emphasis should be as much on improving water and nutrient use efficiency for maintaining sustainable production and good health of the tree [3, 4].

Normally the crop is planted at 6 m x 6 m spacing on flat bed, and irrigation is provided either by flooding or basin irrigation, which results in water stagnation in rhizosphere, thereby making congenial for wilt disease. Fertilisers are generally applied in tree basin along with irrigation, leading to loss of nutrients either through leaching or surface run off. Among different varieties, Lalit, a high yielding pink fleshed variety, selected from the variety Apple Colour, and released by ICAR- Central Institute for Subtropical Horticulture, Lucknow for commercial cultivation in guava growing regions of the country, is responsive to pruning and suitable for high density planting [5].

In high density planting of fruit crops, the exploitation zone of the plants are confined with regard to light, water, and nutrients so that highest total yield potential can be reached in the smallest possible area. With ever-increasing land costs, taxes, production costs, and the need for early returns on invested capital, there is a worldwide trend towards high-density plantings [6]. Spacing of plants in high density planting system depends on fertility of the soil, availability of water, intensity of sunlight and wind exposure. Under high density planting, spacing of guava crop can be 3.0 m (row to row) x 1.5 m (plant to plant), 3.0 m x 3.0 m, or 6.0 m x 3.0 m to accommodate 1111, 2222 and 555 plants per hectare, with cost-benefit ratio of 2.34, 2.13 and 2.02, respectively, at seven years after planting [5].

In guava, two distinct seasons of flowering occur, ambe bahar, i.e. flowering in spring (March-April) mrig bahar, i.e. flowering in rainy season (June-July) from which fruits ripen during rainy and winter season respectively. In North Indian climate the rainy season crop of guava is poor in quality and nutritive value and is affected by many insect pests and diseases. The fruits obtained in winter (September-October) from mrig bahar are superior in quality, taste and higher ascorbic acid content and free from infestation of fruit flies. But it is advisable to take only one crop every year. This requires management of flowering to obtain the most desirable crop, by the methods like root exposure, withholding irrigation, pruning, thinning of flowers by chemically or manually [7]. The concept of crop regulation in guava is based on the fact that guava flowers are borne only on new, succulent, vigorously emerging vegetative growths. These new growth flushes can be either on new emergences of lateral bud on older stems or extensions of already established terminals of various size and vigor. It is necessary to manipulate the flowering in order to get only winter season crop.

Although, the crop is hardy to sustain the moisture stress situation, vegetative phase of the growth as well as the fruit development, are considered to be most critical to the soil moisture regime, since the soil moisture content affect the nutrients and other metabolic process. Availability of adequate, timely and assured irrigation is critical for obtaining optimum growth yield and quality of fruits of guava [2].

In the present-day context, improvement in irrigation practices, including schedules and methods, is needed to increase crop production and to sustain productivity levels. Basin irrigation, widely used in India to irrigate fruit crops, uses more water compared to other high-tech water-saving irrigation methods such as sprinkler and drip [4]. Many researchers have reported the higher application efficiency of drip irrigation systems over the conventional basin irrigation systems [8]. Compared drip and basin irrigation systems in fruits and found that there was savings of 40 to 60% more irrigation water than basin irrigation methods [9]. Reported that irrigation requirement met through drip irrigation along with polythene mulch gave the highest yield of pomegranate (37.70 t/ha) with 164% greater yield as compared to ring basin irrigation [10]. Drip irrigation is undoubtedly the most efficient and advanced technology in India and offers a great promise due to its higher water and nutrient use efficiency by crops against lower amounts of water applied and avoids moisture stress throughout the growing period by providing available moisture at critical crop growth stages [11]. Drip irrigation system in guava is very much appropriate for achieving optimum yield and quality of fruits besides, saving of water. The adoption of drip irrigation also provides effective system to regulate the flowering in guava [2].

In India, Uttar Pradesh is one of the important states where guava (*Psidium guajava*) trees are planted on large scale, often in degraded lands with low fertile soils. Depleted nutrients and absence of efficient nutrient management systems are main factors limiting both guava tree growth and fruit yield [12]. Management of nutrients in guava refers to maintenance of the soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity and fruit quality through optimization of benefits from all the possible sources in integrated manner [2]. Fertigation enables the application of soluble fertilizers and other chemicals along with irrigation water, uniformly and more efficiently [13], has proved its superiority over conventional method of fertilizer application to ensuring the right amounts of irrigation water and plant nutrients available at the root zone and nourishes the crop requirements for stabilizing yield and quality of produce [14]. Fertigation also increases the nutrient use efficiency of crop by permitting timely application of fertilizers in small quantities in the vicinity of root zone matching with the plants' nutrient need, besides substantial saving in fertilizer usage and reducing nutrient losses [15].

Thus drip irrigation along with fertigation provides an effective and cost-efficient way to supply water and nutrients to crops [16]. In guava orchards, generally, there is no use of micronutrients. Micronutrients can be applied to plants by soil and foliar application. Foliar application of micronutrients is more effective than soil application. The importance of micronutrients in achieving higher yield and better quality of fruit crops has been well recognized in recent time. Foliar spray of boron can increase flowering in guava as it regulates metabolism involved in translocation of carbohydrates, cell wall development and RNA synthesis, while zinc can help in normal healthy growth and reproduction of crop, besides increasing fruit size [17]. Indian soils are generally deficient in micronutrients. However, the degree of deficiency is higher in case of Zinc and Boron. The problem of micronutrient management and deficiencies needs to be addressed seriously, particularly in the case of fruit crops. Orchard farming needs special attention in micronutrient management, particularly zinc and boron as fruit quality and productivity is directly related to it [18].

Mulching is an important soil management practice of covering the soil surface around the base of plants to make conditions more favourable for growing and to conserve the available soil moisture. The other well known effects of mulching are regulation of soil temperature, improvement of soil aeration, control of weed population, and also increase the activity of soil micro-organisms. The usual practice of using mulches is to spread the material evenly over the soil surface between the rows and around the plants. The use of material as mulch depends on its availability and mostly economic in nature. The commonly used mulch materials in fruit orchards include pruned materials in fruit orchards, fallen leaves, paddy straw, saw dust, hay etc. However, use of plastic mulch is becoming very popular [19]. Confirmed that the soil cover treatment with black polythene caused maximum (347.95) number of fruits per plant in guava [19]. The use of plastic mulch had significant influences on crop yield of guava as reported [20].

In high density planting of fruit trees, raised bed planting can be preferred over flat bed because plants on raised bed are less prone to water logging, as soils of raised bed dry out more rapidly than flat bed, as reported in strawberry [21]. Indicated that peach trees planted on raised bed had significantly higher biomass, trunk cross-sectional area, fruit yield and production efficiency than those planted on flat bed, which they explained as consequences of faster and more consistent tree growth on raised bed, due to improved root system with deeper roots in raised bed, as compared to restricted root volume in flat bed [22]. Thus, an experiment on precision farming in guava under high density planting (HDP) system with spacing of 3 m x 3 m was initiated during 2015, with an objective of efficient utilization of water and nutrients for improving quality fruit production. The effects of drip irrigation, plastic mulch and fertigation along with micro-nutrient treatments were investigated on plant growth, yield and quality attributes so as to identify the suitable treatment for guava fertigation and water use efficiency.

Materials and Methods

Experimental Site, Trial Design and the Treatments: A field experiment was established out on a sandy loam soil during 2017 in the experimental farm of Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow (26.54 °N latitude, 80.45 °E longitude and 127 m above sea level), Uttar Pradesh, India. The investigation was carried out in guava cv. Lalit to induce mrig bahar from April to October. The experiment was conducted in a randomised block design on guava trees, planted during July, 2015 at a spacing of 3 m × 3 m. The treatment contained combination of different technologies for guava cultivation such as: a). Raised bed cultivation, b). Drip irrigation at 80% open pan evaporation requirement, c). Fertigation at 75% recommended dose of fertiliser (RDF), d). Mulching with 100 micron UV stabilised black polythene, and e). Spray of micro-nutrients (zinc sulphate and boric acid @ 0.2% each) in July and August.

The raised bed was prepared during plantation by pulling top soil from between rows into rows to form beds of 1 meter wide and 15-20 centimetre height, with trees centred on top of the bed. A basin of 60 cm diameter around each plant was made for irrigation and RDF application in control plants. Thus control plants were unmulched, basin irrigated and after first year of planting, control plants were provided with 50:25:50 g N:P:K in tree basin, and doses were increased each year, which will remain constant by sixth year. Fertilisers at 75% RDF were provided along with drip irrigation in three split doses, viz. first week of July, September and November. Soil application of RDF to control plants were done two times a year, viz. half of nitrogen, full Phosphorus and potassium during November, while remaining half of nitrogen during July. Control plants were irrigated every second day during first week of planting and afterwards twice a week for one year, and thereafter at an interval of 10 days. Micro-nutrients (zinc sulphate and boric acid @ 0.2% each) were sprayed in July (fruit set stage) and August (fruit development stage).

Thus there were five treatment combinations such as:

$T_1 = a + b + c + d + e$

$T_2 = a + b + c + d$

$T_3 = a + b + c + e$

$T_4 = a + b + e$ (RDF as soil application)

T_5 = Control (Soil application of RDF, basin irrigation and no mulching)

Each treatment was replicated four times having four plants per replication.

Flower regulation was done during 2016 so as to avoid rainy season crop and encourage winter season crop (mrig bahar). Flowering occurred in July, when growth parameters were recorded and fruits were harvested in third week of November, when yield and quality parameters were recorded.

Mrig Bahar was Induced by Following Steps

1. Withholding water/ irrigation 60 days in advance of normal flowering (March- May under Lucknow condition).
2. Top soil surrounding tree trunk at 60 cm radius was removed to expose the root zone.
3. Manual deblossoming was done during April and May.
4. During June month, plants were provided with watering and manuring (10 kg of well-decomposed farm yard manure per plant).

Measurements and Observations: Growth parameters like canopy spread (North-south and East-West direction), plant height, trunk diameter, and average diameter of primary branches were recorded during September.

Tree canopy volume was calculated by the following formula [23].

Canopy volume (m^3) = Tree height X canopy spread (NS) X canopy spread (EW) X 0.5238

The trunk cross-sectional area (TCSA) was calculated by using formula [24].

TCSA (cm^2) = (Trunk girth at 10 cm height from base)^2/ 4π

Fruits yield and quality traits (fruit length, diameter, volume, total soluble solids, titrable acidity and ascorbic acid) were recorded during November.

Productive Efficiency (PE) was worked out by using the formula suggested [23].

PE (fruits cm^{-2}) = Number of fruits $plant^{-1}$/TCSA

Amount of water applied to each treatment was recorded from May 2016 to April 2017 and Water use efficiency (WUE) was calculated by the following formula:

$$\mathbf{WUE}\left(\frac{\mathbf{g}}{\mathbf{L}}\right) = \frac{\text{Fruit yield per tree per year}\left(\frac{Kg}{\text{tree}\ \text{year}}\right)}{\text{Water applied}\left(\frac{Liter}{\text{tree}\ \text{year}}\right)} \times 1000$$

Water saving percentage was calculated by the following formula:

$$\text{Water saving over control}\ (\%) = \frac{\text{water applied to control} - \text{water applied to treatment}}{\text{Water applied to control}} \times 100$$

Third pairs of leaves from the apex, being a nutritional index for guava [25], were taken from four plants per replication per treatment. The leaf samples were decontaminated by washing first with tap water, then in 0.2% detergent solution and 0.1 N HCl solution followed by washing in single and double distilled water [26]. Excess of water on the surface was removed by pressing between the folds of blotting paper. The leaves were dried in an oven at 48 °C for 72 h, and then they were ground in a grinder. Phosphorus was determined by vanado-molybdate colorimetric method, potassium and the micronutrients, such as iron (Fe), and zinc (Zn) were determined by means of atomic absorption spectrophotometer–AAS (Chemito AA203D model).

Soil samples were collected from the tree basin at depth of 0-30 cm from all treatments before application of fertilisers. Soil organic carbon was estimated by chromic acid digestion method [27]. Available P was estimated by the Olsen method [28] using spectrophotometer and available K was determined by extraction with 1 N ammonium acetate at pH 7.0, by AAS. Available Zn and Fe contents of soil were extracted by DTPA [29]. Concentrations of the above micronutrients in the extract were determined by AAS.

Statistical Design and Analysis of Data: The experimental data were analyzed using the Web Agri Stat Package version WASP2.0 (ICAR Research Complex for Goa, Ela, Goa- 403 402, India). The visual indication of data dispersion on bar and line graphs was achieved by means of the standard error of the mean. Treatment difference was evaluated using the least significant difference (LSD) at $P \leq 0.05$.

Results

Results revealed that T_1 had significant effect on growth attributes in terms of canopy volume, trunk-cross sectional area, and average diameter of primary branches (210.78, 48.02 and 47.94 per cent more than control, respectively), which were statistically non-significant with T_2 for TCSA and primary branch diameter (21.78 and 26.59 per cent more than control, respectively). However, non-significant effects were found among different treatments on average diameter of secondary and tertiary branches, except control (Table 1).

Table 01. Effect of polythene mulching and drip fertigation on growth parameters and production efficiency in guava cv. Lalit grown under raised bed*

	Canopy volume (m^3)**	Trunk cross-sectional area (cm^2)**	Primary branch girth (cm)***	Secondary branch girth (cm)***	Tertiary branch girth (cm)***	Production efficiency (Fruits cm^{-2})***
T_1	14.70 ± 1.24^a	2.99 ± 0.04^a	3.95 ± 0.07^a	2.39 ± 0.10^a	1.44 ± 0.08^a	40.00 ± 0.59^a
T_2	10.02 ± 1.38^b	2.46 ± 0.35^{ab}	3.38 ± 0.29^{ab}	2.22 ± 0.10^a	1.42 ± 0.07^a	39.06 ± 3.54^a
T_3	7.82 ± 0.73^b	2.07 ± 0.25^b	3.25 ± 0.20^b	2.18 ± 0.13^a	1.29 ± 0.08^a	38.65 ± 4.67^a
T_4	6.98 ± 0.87^{bc}	2.03 ± 0.15^b	3.11 ± 0.03^{bc}	2.10 ± 0.12^{ab}	1.19 ± 0.10^{ab}	21.25 ± 1.43^b
T_5	4.73 ± 0.15^c	2.02 ± 0.01^b	2.67 ± 0.19^c	1.81 ± 0.06^b	0.94 ± 0.13^b	18.20 ± 0.62^b

**Means±SEm within column and for each trait with the same letter are not significantly different at $P \le 0.05$; **n = 4; ***n = 16 (Web Agri Stat Package version WASP2.0, ICAR Research Complex for Goa, India).*

The tree produced respectively 119.78, 114.62 and 112.36 per cent more fruits per cm2 TCSA than control, in T_1, T_2 and T_3, while fruit yield was found significant in T_1 (243.51 per cent more than control) (Table 1).

The fruit length, diameter, volume, and vitamin C content were significantly highest in T_1 (6.80 cm, 7.20 cm, 206.50 ml, and 172.03 mg 100 g^{-1} edible portion, respectively), which was statistically non-significant with T_2 for ascorbic acid content (167.35 mg 100 g^{-1}), while titrable acidity was significantly lowest in T_1 and T_2 (0.30%), which was statistically non-significant with T_3 (0.32%). Total soluble solids (TSS) were non-significant among the treatments (Table 2).

Table 02. Effect of polythene mulching and drip fertigation on fruit yield and quality parameters and water utilization in guava cv. Lalit grown under raised bed*

	Yield (kg/tree)***	Fruit length (cm)**	Fruit girth (cm)**	Fruit volume (mL)**	T.S.S (%)**	Titrable acidity (%)**	Ascorbic acid (mg $100g^{-1}$)**	WUE (g/L)***	Water saving over control (%)***
T_1	33.75 ± 0.29^a	6.80 ± 0.04^a	7.20 ± 0.04^a	206.50 ± 1.32^a	14.53 ± 0.21^{NS}	0.30 ± 0.01^b	172.03 ± 2.74^a	8.71 ± 0.08^a	11.36 ± 0.04^d
T_2	26.01 ± 0.26^b	6.08± 0.13b	6.20 ± 0.04^b	129.25 ± 7.40^b	14.08 ± 0.21^{NS}	0.30 ± 0.02^b	167.35 ± 1.12^a	7.33 ± 0.09^b	18.81 ± 0.04^c
T_3	21.42 ± 0.48^c	6.08 ± 0.15^b	6.08 ± 0.15^{bc}	119.50 ± 2.10^{bc}	14.03 ± 0.09^{NS}	0.32 ± 0.02^{ab}	158.08 ± 2.79^b	6.51 ± 0.15^c	24.77 ± 0.05^a
T_4	11.66 ± 0.50^d	5.55 ± 0.18^c	5.75 ± 0.23^c	106.75 ± 6.97^c	13.70 ± 0.28^{NS}	0.36 ± 0.02^a	154.65 ± 3.01^b	3.39 ± 0.15^d	21.26 ± 0.04^b
T_5	10.03 ± 0.20^e	5.08 ± 0.18^d	5.23 ± 0.05^d	75.75 ± 4.55^d	13.36 ± 0.26^{NS}	0.37 ± 0.02^a	144.68 ± 1.92^c	2.30 ± 0.05^e	

**Means±SEm within column and for each trait with the same letter are not significantly different at $P \le 0.05$; **n = 8; ***n = 4 (Web Agri Stat Package version WASP2.0, ICAR Research Complex for Goa, India).*

Water use efficiency was significantly increased by 278.70 per cent in T_1, followed by T_2 (218.70 per cent), as compared to control, although water saving over control was recorded highest in T_3 (24.77%), followed by T_4 (21.26%), T2 (18.81%), and T_1 (11.36%) (Table 2).

The availability of soil organic carbon in tree rhizosphere along with soil nutrients (P, K, Fe and Zn) was non-significant among the treatments including control (Table 3).

Table 03. Effect of polythene mulching and drip fertigation on soil nutrient status of rhizosphere in guava cv. Lalit grown under raised bed*

	SOC (%)**	Soil P (mg / kg)**	Soil K (mg / kg)**	Soil Fe (ppm)**	Soil Zn (ppm)**
T_1	0.58 ± 0.03^{NS}	6.75 ± 0.34^{NS}	82.30 ± 4.24^{NS}	3.54 ± 0.64^{NS}	0.58 ± 0.06^{NS}
T_2	0.56 ± 0.02^{NS}	6.63 ± 0.45^{NS}	80.75 ± 3.12^{NS}	3.21 ± 0.44^{NS}	0.54 ± 0.05^{NS}
T_3	0.56 ± 0.01^{NS}	6.18 ± 0.58^{NS}	78.22 ± 4.97^{NS}	3.13 ± 0.42^{NS}	0.50 ± 0.06^{NS}
T_4	0.55 ± 0.02^{NS}	6.08 ± 0.4^{NS}	76.72 ± 4.99^{NS}	3.09 ± 0.63^{NS}	0.45 ± 0.04^{NS}
T_5	0.55 ± 0.03^{NS}	6.03 ± 0.57^{NS}	75.60 ± 4.62^{NS}	3.06 ± 0.59^{NS}	0.42 ± 0.05^{NS}

**Means±SEm within column and for each trait with NS are not significantly different at $P \le 0.05$; **n = 4 (Web Agri Stat Package version WASP2.0, ICAR Research Complex for Goa, India).*

The leaf P and Fe content were significantly superior in T_1 (45 and 15.22 per cent more than control, respectively), which was non-significant with T_2 for P (20 per cent more than control). However, no significant difference was recorded among the treatments including control for leaf K and Zn content (Table 4).

Table 04. Effect of polythene mulching and drip fertigation on leaf nutrient status in guava cv. Lalit grown under raised bed*

	Leaf P (%)**	Leaf K (%)**	Leaf Fe (ppm)**	Leaf Zn (ppm)**
T_1	0.29 ± 0.032^a	1.66 ± 0.083^{NS}	166.50 ± 1.848^a	17.00 ± 0.913^{NS}
T_2	0.24 ± 0.034^{ab}	1.52 ± 0.035^{NS}	158.50 ± 2.533^b	16.00 ± 0.707^{NS}
T_3	0.20 ± 0.009^b	1.43 ± 0.085^{NS}	146.00 ± 4.416^c	15.50 ± 0.645^{NS}
T_4	0.20 ± 0.005^b	1.40 ± 0.135^{NS}	145.25 ± 2.016^c	14.75 ± 0.854^{NS}
T_5	0.20 ± 0.009^b	1.35 ± 0.155^{NS}	144.50 ± 1.323^c	13.25 ± 1.031^{NS}

*Means±SEm within column and for each trait with the same letter and NS are not significantly different at $P \leq 0.05$; **n = 4 (Web Agri Stat Package version WASP2.0, ICAR Research Complex for Goa, India).

Linear regression model exhibited that with unit increase in tree canopy volume, there was corresponding increase in fruit yield. Similarly, water use efficiency was found to be dependent on tree canopy volume and there existed a positive correlation between them (Fig. 1 & 2).

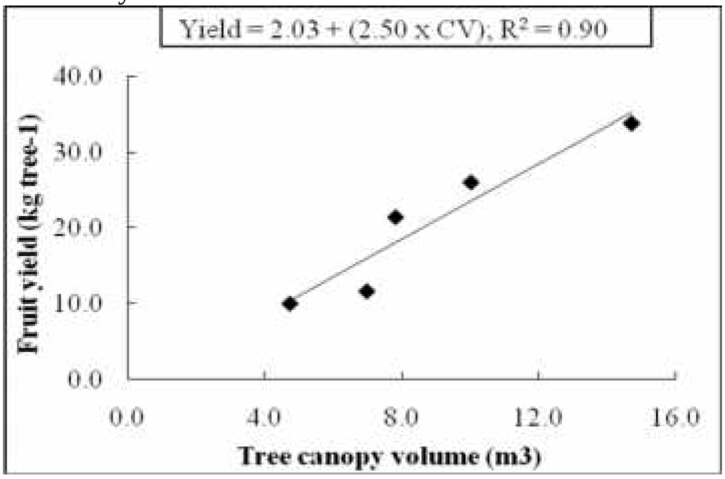

Fig. 01: Linear regression model between tree canopy volume and fruit yield, as influenced by polythene mulching and drip fertigation along with micro-nutrient spray in guava cv. Lalit grown under raised bed (CV indicates canopy volume; analysis done by Web Agri Stat Package version WASP2.0, ICAR Research Complex for Goa, India).

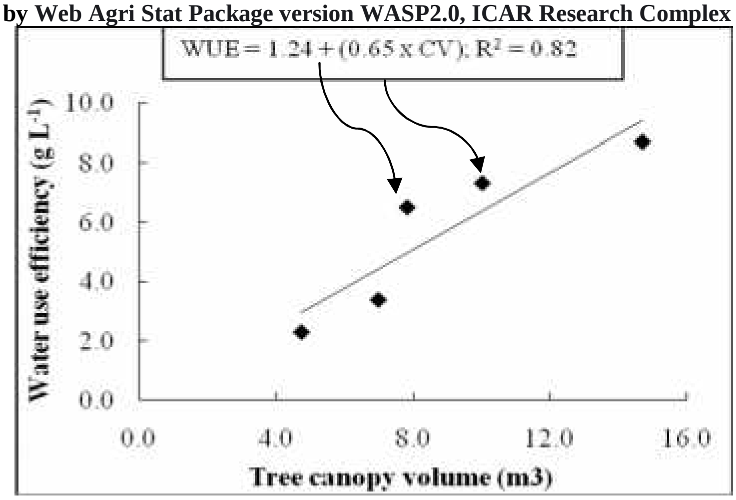

Fig. 02: Linear regression model between tree canopy volume and water use efficiency, as influenced by polythene mulching and drip fertigation along with micro-nutrient spray in guava cv. Lalit grown under raised bed (CV and WUE indicate canopy volume and water use efficiency, respectively; analysis done by Web Agri Stat Package version WASP2.0, ICAR Research Complex for Goa, India).

Discussion

It is well established that plants grown under flat bed condition had restricted root volume as compared to those grown under raised bed condition [22]. Plants grown under restricted rooting volume had thinner and longer primary roots and more secondary and lateral roots. Smaller rooting volume tended to result in a more rapid reduction of soil moisture and led to a smaller trunk, shorter shoot, smaller leaf area, and lower photosynthetic rate, leading to lesser vegetative growth, flowering and fruit yield [30]. Inadequate amount of available water in soil and subsequently in plant during crop growth period hampers various physiological processes in plant and finally the crop yield. In case of drip irrigation, however, the depletion of available soil moisture from same soil depth was quite low as very frequent applications of irrigation water created an adequate environment in soil-plant-atmosphere system and helped for proper growth of the crop [31]. An advantage to fertigation is increased flexibility in application with similar plant response possible at reduced N rates and a potential for multiple reduced rate applications timed to more closely coincide with plant N demand. The timing of N application can be readily modified. The more controlled application of N through fertigation thus offers potential to reduce the leaching of excess N and contamination of groundwater, providing excess irrigation can also be avoided. The mobility of P and K is much greater when fertigated than broadcast, increasing the potential to apply these nutrients rapidly when required [32]. Therefore, drip irrigation along with fertiliser application enables uniform utilisation of water and nutrients by plant, leading to enhanced plant growth, fruit yield and quality, leaf nutrients content and water use efficiency.

Plastic mulch increase soil moisture by reducing loss of water through evaporation, increase nutrient use efficiency by reducing loss of nutrients through leaching, surface run off or volatilisation, eliminates weed growth at the vicinity of tree, thereby providing congenial environment for enhanced tree growth, fruit yield and quality, besides ameleirating leaf nutrient contents and water use efficiency [33]. Improvement in plant growth and yield attributes as a result of application of micronutrients (zinc and boron) might be due to the enhanced photosynthetic and other metabolic activity which leads to an increase in various plant metabolites responsible for cell division and elongation [34].

Thus drip irrigation along with fertiliser application, mulching with black polyethylene and spray of micro-nutrients (zinc sulphate and boric acid) had significant effect on tree performance and water use efficiency under raised bed condition.

Conclusion: Results of the experiment demonstrated that drip irrigation under raised bed condition should be given priority over basin irrigation in flat bed along with mulching with UV stabilised black polythene for fertiliser scheduling in guava orchards of Uttar Pradesh, India on sandy loam soil so that inputs can be efficiently utilised for good quality fruit production, besides increasing water use efficiency. Linear regression analysis revealed significant positive correlation of fruit yield and water use efficiency with canopy volume. Thus efficient use of inputs could improve water use efficiency and reduce fertiliser application to 75% RDF, without compromising on fruit productivity and quality. Therefore, soil fertility status with quality fruit production should find a place in decision support system for guava cultivation.

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