# Influence of Biofertilizers and Bioinoculants on Yield, Quality and Economics of Mallika Mango

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*Abstract:* - A field experiment was conducted to study the "Influence of biofertilizers and bioinoculants on yield, quality and economics of Mallika mango" during the year 2019-20 and 2020-21 at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India using completely randomized design with factorial concept with sixteen treatment combinations comprising two factors *i.e.*, four biofertilizers *viz.*, $D_1$: Bio NPK Consortium (10 ml/tree), $D_2$: VAM (10 g/tree), $D_3$: Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree) and $D_4$: No biofertilizers which were given as drenching at pea stage and four bioinoculants *viz.,* $S_1$: Seaweed extract (0.2 %), $S_2$: Novel organic liquid nutrient (2 %), $S_3$: Jeevamrut (10 %) and $S_4$: No bioinoculants which were sprayed in two frequencies at 2nd week of April and 1st week of May. Treatments were repeated thrice. Maximum fruit volume, number of fruits per panicle at marble and harvest stage, pulp weight, peel weight, pulp:peel stone ratio, yield, ascorbic acid, total sugar, reducing sugar as well as lower value of acidity during pooled analysis with drenching biofertilizers $D_3$: Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree). However, the biofertilizer treatments failed to influence any significant effect on stone weight. Foliar spray of Novel organic liquid nutrient 2 % ($S_2$) gave higher yield and quality parameters *viz.,* maximum fruit volume, number of fruits per panicle at harvest stage, number of fruits per tree, pulp weight, peel weight, pulp:peel stone ratio, yield, ascorbic acid, total sugar, reducing sugar as well as lower value of acidity during pooled analysis. However, the bioinoculants treatments showed non-significant effect on number of fruits per panicle at marble stage and stone weight of fruit. Combine application of biofertilizers and bioinoculants *i.e.*, Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree) with Novel organic liquid nutrient (2 %) found significant in case of number of fruits per panicle at harvest stage, yield, acidity, ascorbic acid, total sugar and reducing sugar. From the economic point of view, higher net realization and benefit cost ratio was obtained in combined application of biofertilizers and bioinoculants treatment $D_3S_2$.

*Key words:* Biofertilizers, bioinoculants, foliar spray, soil drenching, mango

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## 1 Introduction

Mango (*Mangifera indica* L.) has been grown in India since long and is considered as "King of Fruits". It is one of the choicest and most ancient fruits known to mankind. The fruit is considered as a delicacy throughout the world. Mango is national fruit of India, Pakistan and The Philippines. India is proud of having the largest available germplasm wealth of mango with about 1,000 cultivars. [8]. Mango fruit contains unique nutritional and medicinal qualities. Every 100 g mango pulp contains 0.8 g protein, 15 g carbohydrates, 0.4 g fat and 1.6 g dietary fiber. It is also good source of vitamin A and C. It is highly invigorative, laxative and diuretic. [5]. India is the largest producer of mango in the world with 20,265 thousand MT production from an area of 2,281 thousand hectare and productivity of 8.88 MT per hectare. [1]. Among the various states, Uttar Pradesh has the largest area followed by Andhra Pradesh and Karnataka. In Gujarat, total area under mango cultivation is 166 thousand hectare and production is 1222 thousand MT with the productivity of 7.36 MT/ha. [1].

Continuous use of inorganic fertilizers is hazardous to the soil health in respect of physical, chemical and biological properties of soil. Therefore, it is necessary to minimize the application of inorganic fertilizer by substituting with the organics. Integrated use of nutrient supplements *viz.*, organic and inorganic in combination holds a good potential to overcome some of soil physical constraints. Bio-fertilizers are microbial preparations containing living cells of different microorganisms, which have the ability to mobilize plant nutrients of soil from unusable to usable form through biological

process. It cost effective supplement to chemical fertilizers. [14]. Soil drenching with biofertilizers found effective in different fruit crops. Anubhav Bio NPK Consortium contains two nitrogen fixer, two phosphate solubilizers and one potash mobilizer) *Azotobacter chroococcum* (ABA-1), *Azospirillum lipoferum* (ASA-1), *Bacillus coagulans* and two *Bacillus spp*. is the one-time solution for all the macronutrients (N, P, K) requirement of crops. This formulation also provides additional benefits of protecting plant from phytopathogenic fungi and nematodes. VAM (Vesicular Arbuscular Mycorrhiza) has been reported to increase the uptake of phosphorus. It increases the uptake of Zn, Cu, Mn and Fe. Scientific evidences have also suggested that biofertilizer application enhanced growth, yield and quality parameters of fruit crops.

Foliar application of bioinoculants has also become an alternative approach to minimize the use of chemical fertilizers. Several growth regulating bioinoculants like seaweed extract, Novel organic liquid nutrient and jeevamrut have potential in increased growth and development of fruit crops. The use of marine algae or seaweed extracts has received a lot of attention recently because of the increasing interest in the environment, emphasis on clean agriculture and increase the efficiency of fertilizers and thus contribute to lower production costs. [11]. Sap obtained from banana pseudostem contains ample amount of essential nutrient and plant growth hormone (Cytokinin and $GA_3$) for growth and development of crops. Jeevamrut contains enormous amount of microbial load which multiply and act as soil tonic. The biofertilizers and bioinoculants have beneficial effect on yield and quality of fruit crops. By considering these facts, a study on "Influence of biofertilizers and bioinoculants on yield, quality and economics of Mallika mango" was conducted with the aimed to measures the individual as well as interaction effect of biofertilizers and bioinoculants.

# 2 Materials & Methods

## 2.1 Experimental site

An experiment was conducted during the year 2019-20 and 2020-21 on twenty-one years old mango trees planted at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India which is situated geographically at 22º35' North latitude and 72º56' East longitude with an altitude of about 45.1 m above the mean sea level. The soil of the experimental site was loamy sand, locally known as *"Goradu"* having pH 7.14, EC 0.23 $dS.m^{-1}$ and 0.46 % organic C. The available N, P and K of the field soil were 320.00, 34.35 and 442.10 kg $ha^{-1}$, respectively.

## 2.2 Treatment details and observations

Experimental design was CRD with factorial concept with three repetitions. The recommended dose of fertilizers *i. e.,* FYM 100 kg/tree and 750:160:750 kg NPK $ha^{-1}$ were applied. Full dose of FYM, phosphorus, potash and half dose of nitrogen were given after harvest of the crop *i.e.,* June. Remaining half dose of nitrogen was given at pea stage *i.e.,* March. Uniform size trees of Mallika mango was selected as an experimental material which was planted at 8 × 8 m spacing. One tree was selected per treatment and total sixteen treatment combinations were carried out. The details of the treatments applied in the present investigation are as under:

| **Factor A. Drenching of biofertilizers (D)** |
|---|
| $D_1$: Bio NPK Consortium (10 ml/tree) |
| $D_2$: VAM (10 g/tree) |
| $D_3$: Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree) |
| $D_4$: No biofertilizers |
| **Factor B. Spraying of bioinoculants (S)** |
| $S_1$: Seaweed extract (0.2 %) |
| $S_2$: Novel organic liquid nutrient (2 %) |
| $S_3$: Jeevamrut (10 %) |
| $S_4$: No bioinoculants |

Drenching with biofertilizers was given in the ring 1.5 m apart from the tree trunk by incorporation with well decomposed FYM after the week of half nitrogen given at pea stage *i.e.,* 1st week of March. Spraying of bioinoculants was applied to the trees as a preharvest spray in two frequencies in the month of 2nd week of April and 1st week of May as per treatments on trees by foot sprayer.

Fully developed panicles of mango which are uniform, free from disease and pest were selected and tagged randomly on each tree. One panicle was tagged in each direction and total 4 panicles were tagged on each tree to record the count of number of fruits per panicle at marble and harvest stage. At mature uniform sized fresh mango fruits per tree were harvested and kept in the laboratory. The five mature fruits per treatment were randomly selected and all observations regarding physical and biochemical parameters of fruits were recorded

under ambient storage condition. Titratable acidity, ascorbic acid and sugar content of the fruits were determined. [20]. Data for individual years were analyzed and in order to study the average effect of different treatments over the years, the pooled analysis was also worked out. [10]. In order to evaluate the effectiveness of each treatment, the relative economics of each treatment was worked out in terms of net profit so, that the most effective and remunerative treatment could be found out.

# 3 Results and discussion

The experimental findings obtained from the present study have been discussed here in following heads:

## 3.1 Yield attributes

### 3.1.1 Influence of biofertilizers

The drenching of biofertilizers significantly influenced the yield parameters of mango (Table 1 and 2). The yield parameters in terms of fruit volume (349.63, 336.20 and 342.91 cc) were noted maximum with drenching of Bio NPK Consortium 10 ml/tree + VAM 10 g/tree) during the year 2019-20, 2020-21 and in pooled mean data, respectively. The higher number of fruits per panicle at marble stage (10.68, 10.12 and 10.40), number of fruits per panicle (1.80, 1.66 and 1.73) at harvest stage, pulp weight (237.38, 231.67 and 234.52 g), peel weight (46.50, 43.44 and 44.97 g), pulp:peel stone ratio (2.71, 2.75 and 2.73) and fruit yield (13.73, 13.02 and 13.38 t/ha).

It might be due to biofertilizers (Bio NPK Consortium + VAM) may supply optimum plant nutrients and growth hormones at desired amount during entire period of fruit growth, ultimately increases higher rate of photosynthesis resulted in more accumulation of dry matter responsible for more fruit volume of mango fruit. Maximum number of fruits per panicle at marble and harvest stage might be due to supply of all the nutrients in adequate right from starting of the experiment to the harvesting of the crop, which induced more retention of fruits by supply of photosynthates at critical requirement stage and that resulted into increased fruit yield. Biofertilizers have direct relation in N fixation, solubilizing phosphorus, production of phytohormone which increased the uptake of nutrients that ultimately increases pulp:peel stone ratio of mango fruits. [24, 12, 19 6 and 16].

### 3.1.2 Influence of bioinoculants

The spraying with bioinoculants significantly influenced on the yield parameters of Mallika mango (Table 1 and 2). Spraying of Novel organic liquid nutrient 2 % gave maximum fruit volume (336.80, 322.66 and 329.73 cc), number of fruits per panicle at harvest stage of mango (1.71, 1.56 and 1.63), pulp weight (224.45, 217.32 and 220.88 g), peel weight (44.64, 41.66 and 43.15 g), pulp:peel stone ratio (2.62, 2.65 and 2.63) and fruit yield (13.25, 12.53 and 12.89 t/ha) during 2019-20, 2020-21 and pooled mean, respectively. Bioinoculants show non-significant response on number of fruits per panicle at marble stage and stone weight of mango.

Novel organic liquid nutrient provides higher carbohydrate accumulation in plant at early stage of growth as a resulted in better nutrient supply, which causes an increased in fruit size and there by increased the fruit volume. [18]. It also has a good amount of K and the role of K in reducing the fruit drop is expected due to its catalytic effect in biochemical reactions occurring in physiological processes of the plant [4] and also responsible for enhancement of auxin in the plant which is known to reduce fruit drop and increase the fruit retention by delaying the formation of abscission layer. [15 and 21].

### 3.1.3 Interaction effect of biofertilizers and bioinoculants

Maximum number of fruits per panicle at harvest stage (1.93) and maximum fruit yield (14.87 t/ha) in pooled result (Table 3) was observed with combined application of *i.e*., drenching with biofertilizers like Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree) and spraying with bioinoculants *viz.*, Novel organic liquid nutrient (2 %).

Increased number of fruits per panicle at harvest stage and fruit yield is might be due to the combine effect of drenching with biofertilizers (Bio NPK Consortium + VAM) at critical stage *viz*., pea stage and spraying with bioinoculant (Novel organic liquid nutrient) that provides essential macro nutrient (N, P and K) in adequate quantity, VAM may increase uptake of phosphorus and other micronutrients (Zn, Cu, Mn, Fe) as well as spraying with Novel organic liquid nutrient act as a growth stimulant which have regulatory role in more fruit retention upto harvest period ultimately increases fruit yield. [7, 21 and 23].

**Table 1.** Effect of biofertilizers and bioinoculants on fruit volume, number of fruits per panicle at marble and harvest stage of Mallika mango

| Treatments | Fruit volume (cc) | | | Number of fruits per panicle at marble stage | | | Number of fruits per panicle at harvest stage | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled |
| **Biofertilizers as drenching (D)** | | | | | | | | | |
| $D_1$ | 337.40 | 323.78 | 330.59 | 10.39 | 9.81 | 10.10 | 1.67 | 1.51 | 1.59 |
| $D_2$ | 322.83 | 309.73 | 316.28 | 9.99 | 9.42 | 9.71 | 1.60 | 1.45 | 1.52 |
| $D_3$ | 349.63 | 336.20 | 342.91 | 10.68 | 10.12 | 10.40 | 1.80 | 1.66 | 1.73 |
| $D_4$ | 279.24 | 265.21 | 272.23 | 8.89 | 8.28 | 8.59 | 1.31 | 1.17 | 1.24 |
| S.Em.± | 8.58 | 8.97 | 6.21 | 0.26 | 0.28 | 0.19 | 0.03 | 0.04 | 0.03 |
| CD at 5 % | 24.72 | 25.86 | 17.55 | 0.74 | 0.80 | 0.54 | 0.10 | 0.11 | 0.07 |
| **Bioinoculants as spraying (S)** | | | | | | | | | |
| $S_1$ | 328.85 | 316.79 | 322.82 | 10.07 | 9.55 | 9.81 | 1.65 | 1.50 | 1.57 |
| $S_2$ | 336.80 | 322.66 | 329.73 | 10.21 | 9.75 | 9.98 | 1.71 | 1.56 | 1.63 |
| $S_3$ | 325.13 | 310.55 | 317.84 | 10.03 | 9.46 | 9.75 | 1.60 | 1.46 | 1.53 |
| $S_4$ | 298.32 | 284.93 | 291.62 | 9.64 | 8.86 | 9.25 | 1.43 | 1.28 | 1.35 |
| S.Em.± | 8.58 | 8.97 | 6.21 | 0.26 | 0.28 | 0.19 | 0.03 | 0.04 | 0.03 |
| CD at 5 % | 24.72 | 25.86 | 17.55 | NS | NS | NS | 0.10 | 0.11 | 0.07 |
| **Interaction (D x S)** | | | | | | | | | |
| S.Em.± | 17.16 | 17.95 | 12.41 | 0.47 | 0.54 | 0.36 | 0.07 | 0.08 | 0.06 |
| CD at 5 % | NS | NS | NS | NS | NS | NS | NS | NS | Sig. |

**Table 2.** Effect of biofertilizers and bioinoculants on pulp weight, peel weight, stone weight, pulp:peel stone ratio and yield of Mallika mango

| Treatments | Pulp weight (g) | | | Peel weight (g) | | | Stone weight (g) | | | Pulp:peel stone ratio | | | Fruit yield (t/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled |
| **Biofertilizers as drenching (D)** | | | | | | | | | | | | | | | |
| $D_1$ | 223.77 | 217.57 | 220.67 | 44.57 | 41.85 | 43.21 | 40.85 | 40.50 | 40.67 | 2.63 | 2.64 | 2.64 | 13.06 | 12.33 | 12.69 |
| $D_2$ | 207.49 | 202.26 | 204.87 | 42.82 | 39.77 | 41.29 | 40.27 | 39.95 | 40.11 | 2.50 | 2.54 | 2.52 | 12.29 | 11.53 | 11.91 |
| $D_3$ | 237.38 | 231.67 | 234.52 | 46.50 | 43.44 | 44.97 | 41.29 | 40.87 | 41.08 | 2.71 | 2.75 | 2.73 | 13.73 | 13.02 | 13.38 |
| $D_4$ | 157.15 | 152.44 | 154.79 | 36.99 | 34.00 | 35.50 | 38.46 | 38.51 | 38.49 | 2.09 | 2.10 | 2.09 | 10.39 | 9.80 | 10.09 |
| S.Em.± | 5.99 | 4.36 | 3.70 | 1.09 | 0.99 | 0.74 | 1.11 | 0.95 | 0.73 | 0.10 | 0.07 | 0.06 | 0.22 | 0.28 | 0.18 |
| CD at 5 % | 17.26 | 12.56 | 10.47 | 3.15 | 2.86 | 2.09 | NS | NS | NS | 0.28 | 0.20 | 0.17 | 0.62 | 0.80 | 0.49 |
| **Bioinoculants as spraying (S)** | | | | | | | | | | | | | | | |
| $S_1$ | 213.30 | 208.20 | 210.75 | 43.57 | 40.83 | 42.20 | 40.46 | 40.16 | 40.31 | 2.53 | 2.56 | 2.54 | 12.65 | 11.93 | 12.29 |
| $S_2$ | 224.45 | 217.32 | 220.88 | 44.64 | 41.66 | 43.15 | 40.84 | 40.46 | 40.65 | 2.62 | 2.65 | 2.63 | 13.25 | 12.53 | 12.89 |
| $S_3$ | 209.99 | 203.92 | 206.95 | 43.12 | 40.01 | 41.57 | 40.32 | 40.05 | 40.19 | 2.53 | 2.54 | 2.53 | 12.42 | 11.74 | 12.08 |
| $S_4$ | 178.05 | 174.49 | 176.27 | 39.55 | 36.57 | 38.06 | 39.24 | 39.16 | 39.20 | 2.26 | 2.30 | 2.28 | 11.15 | 10.48 | 10.81 |
| S.Em.± | 5.99 | 4.36 | 3.70 | 1.09 | 0.99 | 0.74 | 1.11 | 0.95 | 0.73 | 0.10 | 0.07 | 0.06 | 0.22 | 0.28 | 0.18 |
| CD at 5 % | 17.26 | 12.56 | 10.47 | 3.15 | 2.86 | 2.09 | NS | NS | NS | 0.28 | 0.20 | 0.17 | 0.62 | 0.80 | 0.49 |
| **Interaction (D x S)** | | | | | | | | | | | | | | | |
| S.Em.± | 11.98 | 8.71 | 7.41 | 2.19 | 1.98 | 1.48 | 2.21 | 1.89 | 1.46 | 0.20 | 0.14 | 0.12 | 0.43 | 0.55 | 0.35 |
| CD at 5 % | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | Sig. |

**Table 3.** Interaction effect of biofertilizers and bioinoculants on number of fruits per panicle at harvest stage and yield (t/ha) of mango (Pooled result)

| Code | Number of fruits per panicle at harvest stage | Yield (t/ha) |
|---|---|---|
| $D_1S_1$ | 1.66 | 13.34 |
| $D_1S_2$ | 1.68 | 13.46 |
| $D_1S_3$ | 1.63 | 12.85 |
| $D_1S_4$ | 1.40 | 11.12 |
| $D_2S_1$ | 1.58 | 12.15 |
| $D_2S_2$ | 1.61 | 12.50 |
| $D_2S_3$ | 1.52 | 12.02 |
| $D_2S_4$ | 1.39 | 10.98 |
| $D_3S_1$ | 1.83 | 13.65 |
| $D_3S_2$ | 1.93 | 14.87 |
| $D_3S_3$ | 1.74 | 13.56 |
| $D_3S_4$ | 1.43 | 11.42 |
| $D_4S_1$ | 1.22 | 10.02 |
| $D_4S_2$ | 1.32 | 10.72 |
| $D_4S_3$ | 1.22 | 9.90 |
| $D_4S_4$ | 1.20 | 9.74 |
| S.Em.± | 0.05 | 0.35 |
| CD at 5 % | 0.14 | 0.99 |

## 3.2 Quality attributes

### 3.2.1 Influence of biofertilizers

Drenching with biofertilizers treatment significantly affected the quality of mango (Table 4). Minimum acidity (0.29, 0.26 and 0.27 %), maximum ascorbic acid (28.41, 26.77 and 27.59 mg/100 g), total sugar (19.47, 19.18 and 19.33 %) and reducing sugar (8.72, 8.46 and 8.59 %) was noted in treatment of Bio NPK Consortium 10 ml/tree + VAM 10 g/tree during the year 2019-20, 2020-21 and in pooled data, respectively.

The decrease in acidity of fruits may be attributed to their conversion into sugars and their derivatives by the reactions involving reversal of glycolytic pathway or might be used in respiration or both. Soil drenching of microbial consortium in conjunction with VAM improved soil physical condition, enhanced root development by mycellial network of microorganisms, increased moisture retention and thus improved water absorption, and steady flow of nitrogen and other essential minerals which augment photosynthesis of plant leading in more starch reserve in shoots and roots which is translocation from shoots to fruits during maturation helps in formation of ascorbic acid. Application of Bio NPK Consortium along with VAM might have performed regulatory role on absorption of nutrients and translocation of metabolites especially carbohydrates reserve in roots and stem which hydrolyzed into sugar during ripening which improve the sugar content of fruits. [3, 7, 9 and 6].

### 3.2.2 Influence of bioinoculants

Among the different bioinoculants treatment lower acidity (0.32, 0.30 and 0.31 %), ascorbic acid (27.37, 25.62 and 26.49 mg/100 g), total sugar (19.03, 18.75 and 18.89 %) and reducing sugar (8.49, 8.25 and 8.37 %) was observed in spraying with Novel organic liquid nutrient 2 % in the years 2019-20, 2020-21 and pooled, respectively (Table 4).

The fermented novel organic liquid nutrient contains higher amount of potassium. [13]. The role of potassium in improvement of fruit quality is well documented. [2]. Increased in sugar content and decreased acidity content might be due to respirational demand and adequate supply of nutrients, synthesis of invertase and starch splitting enzymes. [18, 22 and 17].

### 3.2.3 Interaction effect of biofertilizers and bioinoculants

Table 5 and 6 showed that combine application of both drenching of biofertilizers *i.e.,* Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree) and spraying with Novel organic liquid nutrient (2 %) resulted in maximum ascorbic acid (29.43 mg/100 g) and reducing sugar (9.12 %) in pooled analysis, minimum acidity (0.23, 0.21 and 0.22 %) and maximum total sugar (20.60, 20.28 and 20.44 %) in both the years and pooled data, respectively.

Combine application of biofertilizers and bioinoculants increases the metabolic activity and convert more sugar by synthesis of starch splitting enzymes which decreased acidity content and increased sugar content of fruits. This treatment also promotes good physical condition of soil by mycelial network of microorganism that translocate higher amount of starch with Bio NPK Consortium and spraying of Novel organic liquid nutrient contains macro, micro elements and plant growth regulators which might helped in improving the fruit quality of fruit [7, 18 and 12].

**Table 4.** Effect of biofertilizers and bioinoculants on acidity, ascorbic acid, total sugar and reducing sugar of Mallika mango

| Treatments | Acidity (%) | | | Ascorbic acid (mg/100 g) | | | Total sugar (%) | | | Reducing sugar (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled |
| **Biofertilizers as drenching (D)** | | | | | | | | | | | | |
| $D_1$ | 0.33 | 0.31 | 0.32 | 27.46 | 25.64 | 26.55 | 18.98 | 18.63 | 18.81 | 8.49 | 8.23 | 8.36 |
| $D_2$ | 0.37 | 0.34 | 0.36 | 26.04 | 24.17 | 25.11 | 18.36 | 18.11 | 18.23 | 8.21 | 7.98 | 8.09 |
| $D_3$ | 0.29 | 0.26 | 0.27 | 28.41 | 26.77 | 27.59 | 19.47 | 19.18 | 19.33 | 8.72 | 8.46 | 8.59 |
| $D_4$ | 0.42 | 0.40 | 0.41 | 22.13 | 19.97 | 21.05 | 16.58 | 16.49 | 16.53 | 7.30 | 7.16 | 7.23 |
| S.Em.± | 0.003 | 0.004 | 0.002 | 0.24 | 0.24 | 0.17 | 0.13 | 0.12 | 0.09 | 0.07 | 0.06 | 0.05 |
| CD at 5 % | 0.01 | 0.01 | 0.01 | 0.68 | 0.69 | 0.48 | 0.38 | 0.35 | 0.25 | 0.20 | 0.18 | 0.13 |
| **Bioinoculants as spraying (S)** | | | | | | | | | | | | |
| $S_1$ | 0.33 | 0.31 | 0.32 | 26.57 | 24.78 | 25.68 | 18.60 | 18.38 | 18.49 | 8.31 | 8.07 | 8.19 |
| $S_2$ | 0.32 | 0.30 | 0.31 | 27.37 | 25.62 | 26.49 | 19.03 | 18.75 | 18.89 | 8.49 | 8.25 | 8.37 |
| $S_3$ | 0.34 | 0.32 | 0.33 | 26.25 | 24.33 | 25.29 | 18.45 | 18.15 | 18.30 | 8.22 | 8.01 | 8.11 |
| $S_4$ | 0.41 | 0.38 | 0.39 | 23.85 | 21.83 | 22.84 | 17.31 | 17.13 | 17.22 | 7.69 | 7.50 | 7.59 |
| S.Em.± | 0.003 | 0.004 | 0.002 | 0.24 | 0.24 | 0.17 | 0.13 | 0.12 | 0.09 | 0.07 | 0.06 | 0.05 |
| CD at 5 % | 0.01 | 0.01 | 0.01 | 0.68 | 0.69 | 0.48 | 0.38 | 0.35 | 0.25 | 0.20 | 0.18 | 0.13 |
| **Interaction (D x S)** | | | | | | | | | | | | |
| S.Em.± | 0.01 | 0.01 | 0.01 | 0.47 | 0.48 | 0.34 | 0.27 | 0.24 | 0.18 | 0.14 | 0.13 | 0.09 |
| CD at 5 % | Sig. | Sig. | Sig. | NS | NS | Sig. | Sig. | Sig. | Sig. | NS | NS | Sig. |

**Table 5.** Interaction effect of biofertilizers and bioinoculants on acidity and total sugar of mango

| Code | Acidity (%) | | | Total sugar (%) | | |
|---|---|---|---|---|---|---|
| | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled |
| $D_1S_1$ | 0.30 | 0.28 | 0.29 | 19.38 | 19.09 | 19.24 |
| $D_1S_2$ | 0.29 | 0.27 | 0.28 | 19.55 | 19.15 | 19.35 |
| $D_1S_3$ | 0.33 | 0.30 | 0.32 | 19.33 | 18.86 | 19.10 |
| $D_1S_4$ | 0.40 | 0.37 | 0.39 | 17.65 | 17.44 | 17.55 |
| $D_2S_1$ | 0.35 | 0.33 | 0.34 | 18.68 | 18.39 | 18.53 |
| $D_2S_2$ | 0.35 | 0.32 | 0.33 | 18.83 | 18.56 | 18.70 |
| $D_2S_3$ | 0.37 | 0.34 | 0.35 | 18.41 | 18.17 | 18.29 |
| $D_2S_4$ | 0.41 | 0.38 | 0.39 | 17.52 | 17.30 | 17.41 |
| $D_3S_1$ | 0.26 | 0.24 | 0.25 | 19.82 | 19.53 | 19.67 |
| $D_3S_2$ | 0.23 | 0.21 | 0.22 | 20.60 | 20.28 | 20.44 |
| $D_3S_3$ | 0.27 | 0.24 | 0.26 | 19.66 | 19.32 | 19.49 |
| $D_3S_4$ | 0.38 | 0.35 | 0.37 | 17.81 | 17.60 | 17.71 |
| $D_4S_1$ | 0.42 | 0.39 | 0.40 | 16.54 | 16.50 | 16.52 |
| $D_4S_2$ | 0.41 | 0.38 | 0.40 | 17.14 | 17.02 | 17.08 |
| $D_4S_3$ | 0.42 | 0.39 | 0.40 | 16.38 | 16.26 | 16.32 |
| $D_4S_4$ | 0.45 | 0.42 | 0.44 | 16.24 | 16.18 | 16.21 |
| S.Em.± | 0.007 | 0.007 | 0.005 | 0.27 | 0.24 | 0.18 |

**Table 6.** Interaction effect of biofertilizers and bioinoculants on ascorbic acid and reducing sugar of mango (Pooled result)

| Code | Ascorbic acid (mg/100 g) | Reducing sugar (%) |
|---|---|---|
| $D_1S_1$ | 27.40 | 8.55 |
| $D_1S_2$ | 27.83 | 8.59 |
| $D_1S_3$ | 27.04 | 8.53 |
| $D_1S_4$ | 23.94 | 7.76 |
| $D_2S_1$ | 25.64 | 8.27 |
| $D_2S_2$ | 26.34 | 8.30 |
| $D_2S_3$ | 25.36 | 8.13 |
| $D_2S_4$ | 23.09 | 7.67 |
| $D_3S_1$ | 28.39 | 8.71 |
| $D_3S_2$ | 29.43 | 9.12 |
| $D_3S_3$ | 27.89 | 8.69 |
| $D_3S_4$ | 24.66 | 7.85 |
| $D_4S_1$ | 21.29 | 7.23 |
| $D_4S_2$ | 22.38 | 7.49 |
| $D_4S_3$ | 20.88 | 7.12 |
| $D_4S_4$ | 19.67 | 7.09 |
| S.Em.± | 0.34 | 0.09 |
| CD at 5 % | 0.95 | 0.27 |

## 3.3 Economics

The mean data on cost of cultivation incurred with gross realization, net realization and benefit cost ratio of mango as affected by different treatments of biofertilizers and bioinoculant are presented in Table 7.

The data revealed that among the different treatments, drenching with $D_3S_2$ [Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree) followed by spraying of Novel organic liquid nutrient (2 %)] per tree recorded the highest net realization *i.e.,* Rs. 339173 per hectare with BCR (3.17).

**Table 7.** Influence of biofertilizers and bioinoculants on economics of Mallika mango

| Treatments | | Fruit yield (t/ha) | Gross realization (Rs./ha) | Common cost of cultivation (Rs./ha) | Treatment cost (Rs./ha) | Total cost of cultivation (Rs./ha) | Net realization (Rs./ha) | Benefit cost ratio |
|---|---|---|---|---|---|---|---|---|
| $T_1$ | $D_1 S_1$ | 13.34 | 400200 | 93677 | 6584 | 100261 | 299939 | 2.99 |
| $T_2$ | $D_1 S_2$ | 13.46 | 403800 | 93677 | 12484 | 106161 | 297639 | 2.80 |
| $T_3$ | $D_1 S_3$ | 12.85 | 385500 | 93677 | 6359 | 100036 | 285464 | 2.85 |
| $T_4$ | $D_1 S_4$ | 11.12 | 333600 | 93677 | 2768 | 96445 | 237155 | 2.46 |
| $T_5$ | $D_2 S_1$ | 12.15 | 364500 | 93677 | 6190 | 99867 | 264633 | 2.65 |
| $T_6$ | $D_2 S_2$ | 12.50 | 375000 | 93677 | 12090 | 105767 | 269233 | 2.55 |
| $T_7$ | $D_2 S_3$ | 12.02 | 360600 | 93677 | 5965 | 99642 | 260958 | 2.62 |
| $T_8$ | $D_2 S_4$ | 10.98 | 329400 | 93677 | 2374 | 96051 | 233349 | 2.43 |
| $T_9$ | $D_3 S_1$ | 13.65 | 409500 | 93677 | 7350 | 101027 | 308473 | 3.05 |
| $T_{10}$ | $D_3 S_2$ | 14.87 | 446100 | 93677 | 13250 | 106927 | 339173 | 3.17 |
| $T_{11}$ | $D_3 S_3$ | 13.56 | 406800 | 93677 | 7125 | 100802 | 305998 | 3.04 |
| $T_{12}$ | $D_3 S_4$ | 11.42 | 342600 | 93677 | 3534 | 97211 | 245389 | 2.52 |
| $T_{13}$ | $D_4 S_1$ | 10.02 | 300600 | 93677 | 3816 | 97493 | 203107 | 2.08 |
| $T_{14}$ | $D_4 S_2$ | 10.72 | 321600 | 93677 | 9716 | 103393 | 218207 | 2.11 |
| $T_{15}$ | $D_4 S_3$ | 9.90 | 297000 | 93677 | 3591 | 97268 | 199732 | 2.05 |
| $T_{16}$ | $D_4 S_4$ | 9.74 | 292200 | 93677 | 0 | 93677 | 198523 | 2.12 |

Price of mango fruit: Rs 30/kg

## 4 Conclusion

From the two years of field study, it can be concluded that drenching of biofertilizers like Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree) at pea stage increased yield and quality of fruits. Similarly, spraying of Novel organic liquid nutrient (2 %) per tree twice at 2nd week of April and 1st week of May enhanced yield and improved quality of fruits. Further, combined effect of biofertilizers like Bio NPK Consortium (10 ml/tree) + VAM (10 g/tree) at pea stage with spraying of Novel organic liquid nutrient (2 %) per tree twice at 2nd week of April and 1st week of May increased yield and quality with BCR.

**Conflict of Interest: None declared**

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