Fruit Characteristics and Yield of Mango cv. Amrapalias Influenced byBio-enhancers and Bio-fertilizers

ABSTRACT

To study the **"Fruit Characteristics and Yield of Mango cv. Amrapali as Influenced byBio-enhancers and Bio-fertilizers"**a field experiment was conducted in the Garden, Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) during 2020-2021. The experiment consists of seven treatments *i.e.*, FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control, FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Amritpani (20%) + *Azotobacter* (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Amritpani (20%) + PSB culture (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB culture (100g/tree) which were replicated thrice inrandomized block design by using one plant as a unit per treatment. The application of different bio-enhancers and bio-fertilizers to mango plant was made as per the requirement of the treatment.

The experimental results clearly revealed that the plants treated with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) produced fruits with significantly higher length, width, weight,volume, pulp weight, pulp:peel ratio with more yield. However, the fruit with minimum fruit length, width, weight, volume, pulp weight, pulp:peel ratio, andyield wererecorded from the plants treated with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control.Thus, on the basis of the above observations, this can be suggested that theapplication of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) were effective forsubstantially higher physical fruit characteristicsand yieldunder the sub-tropical plains of Central Uttar Pradesh, India.

Keywords: Mango, Amrapali, *Azotobacter*, Panchagavya, Physical characteristics, PSB, Jivamrit, Organic mulch.

1. Introduction:

Mango (*Mangifera indica* L.) an important commercial fruit crop of Indiawhich is knownas "Kingof Fruits". It is widely cultivated throughout the tropical andsub-tropical zones of world except in hilly regions. It grows well in alluvial to lateritic soil types which are considered to be good for its cultivation. Mango is a nutritionally rich fruit and 100 g pulp of mango fruit encompasses about 81.7 g water, 16 g carbohydrate, 0.7 g protein, 0.4 g fat and 0.1 g fibre. A single fruit can provide up to 40% of daily dietary fibre needs **(Singh *et al.*, 2018).**

The use of bio-fertilizers and bio-enhancers formulations has great importance for sustainable production and to improve the soils physical, chemical and biological properties. The increasing cost of chemical fertilizers and their harmful effects on soil health became a major issue for growers. Therefore, cost-effective, sustainable and alternative organic sources are required to fulfil the nutrient requirements.

The important bio-enhancers can be prepared at the farmer's field are Panchagavya,Amritpani, Jivamrit, Bijamrit, Vermiwash*etc*.**(Pathak and Ram, 2013).**Use of these in fruit crops enhances the quality of fruits and improve the yield attributes, thereby results in higher soil fertility, crop quality, and crop productivity. Amritpani, it is an important bio-enhancer, which can easily be prepared by the farmers itself. The available micro-organism in Amritpani are *Actinomycetes*, *Pseudomonas*, Phosphorous solubilising bacteria, *Azotobacter* and *Azospirilum*. Jivamrit, is also prepared the same as Amritpani except the addition of some other ingredients such as jaggery and pulse flour and banyan tree soil. The micro-organism in Jivamrit is also more or less the same as Amritpani. **(Ram and Pathak, 2007).**

Bio-fertilizers are the living or latent cells which have the capacity of mobilizing the soil nutrients in the soil from unavailable to available form by microbial activities. The use of bio-fertilizers like *Azotobacter* and PSB with organic mulchthrough paddy straw along with the application of farm yard manure. play a significant role in enhancing crop production and are referred to as eco-friendly and cost-effective in nature for farmers.

The integration of bio-enhancers and bio-fertilizers components when applied in an appropriate ratio to the mango tree components will help to supply a balanced supply of micro and macronutrients and enhance the yield. It further also improves soil health by providing sustainable highproductivityon a long-termbasis**(Ghosh, 2009).**Thus, keeping the

above fact in view, an experiment was conducted to assess the "FruitCharacteristics and Yield of Mango cv. Amrapalias Influencedby Bio-enhancers and Bio-fertilizers.**"**

2. Materials and Method

Weather and climate details: The experimental site, in general is bestowed with sub-tropical climate with hot dry summer and cold winters. The mean annual rainfall of the experimental site is 800-880mm of which 70-75 per cent rainfall is received from June to September, whereas remaining 25-30 per cent of rains is received in few showers during winters.

Experimental site: An investigation was conducted in the Garden, Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.). Geographically, the experimental site is located at 25^0 26′ N latitude and 79^0 31 ′E longitude at an elevation of 125.90 meters above mean sea level falling in the alluvial belt of Gangatic plains located in the central part of Uttar Pradesh, India.

Soil type: The soil of the experimental field was sandy loam in texture, and slightly alkaline in reaction, low in organic carbon (3.9 g/kg), available nitrogen(168.89 kg/ha) but medium in available phosphorus (21.63 kg/ha) and potassium (263.13kg/ha) with electrical conductivity ($0.46 dSm^{-1}$at 25^0C).

Experimental design and treatment details: The field experiment comprised of seven treatments, which were laid out in randomized block design with three replications. The treatments comprised of FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control, FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Amritpani (20%) + *Azotobacter* (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Amritpani (20%) + PSB culture (100g/tree), FYM (25 kg/tree/year) + Organic mulch(Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree), FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB culture (100g/tree).

Methodology and crop management: In mango cultivar Amrapali, application of bio-enhancers and bio-fertilizers was applied as per the requirement of the treatments. The application of bio-enhancers and bio-fertilizers were done before and after flowering. For the foliarspray on mango plant such as to adequately drench the entire foliage, 10 litres of solution was used for the spraying which is done by using pneumatic foot sprayer fitted with nozzle in the afternoon from 4.00 pm to 6.00 pm. For spraying on top of plant, high legged

stool was used to fully ensure that all side of the plant was drenched completely. To avoid the spread of surplus spray under the plants, Paddy straw was used as mulch material in the root zone area of plants. Further, the crop was managed as per regional recommendations of the crop.

Fruit characteristics and Yield:

Data on various physical characteristics were recorded after the fruits were ripened and removed from the tree. Physical attributes *viz.* fruit length, width,weight, volume, peel weight pulp weight, pulp:peel ratio wasrecorded fromrandomly selected5 fruits from the tree. Data on yield were recorded by weighing all the harvested fruit on a weighing machine.

Statistical analysis: Statistical analysis onphysical attributes and yield was performed to examine the effect of different treatments. The analysis of variance was conducted using OP-Stat developed by CCSHAU, Hisar for all observations recorded during the years. Fisher's test of significance was used to compare the difference between means at 5 % probability level. Standard errors along with critical difference at 5 % of significance were computed for discriminating the treatment effects for chance effects.

3. Results and discussion

Fruit Size (length and width of fruits):

The data related to fruit size(length and width) ispresented in Table 1 revealed thatthe fruits maximum length and width(10.20and 6.15cm,respectively)were recorded in fruits which wereproducedfrom the mango plants which were treated with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) which was statistically at par with the fruits which were produced from the plants which were treated with FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree) (9.73 and 5.90 cm, respectively) and FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree)(9.60 and 5.75 cm, respectively). The minimum fruit length and width(8.30and 4.80 cm, respectively) was recorded in fruits which were produced from the mango plants which were fertilized with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control. This may be because panchgavya and jivamrit contain significant numbers of helpful microbial populations, as well as small amounts of macronutrients, micronutrients, and growth-promoting substances that, when applied to crops as foliar spray and through soil, encourage

the necessary plant growth. Additionally, liquid bio-enhancer along with bio-fertilizers makes nitrogen and phosphorus more available to produce larger cells with thinner cell walls, contribute to cell division and elongation, promote vegetative growth, and ultimately improve metabolic and photosynthetic activity for improving the biological efficiency of the plant **(Upperi*et al*., 2009)**. This results in the accumulation of more carbohydrates and higher nutrients. These findings were supported by the results by **Shubha *et al*. (2014), Ramesh *et al.* (2015), Sharma *et al.* (2022), Siddappa *et al*. (2016).Tripathi *etal.,* (2014)** also recorded maximum size of fruits in strawberry with the application of *Azotobactor* and PSB each at 6kg per hectare.

Fruit weight (g):

It was observed that the fruits with maximum weight (223.93g) was recorded in fruits which were produced from the plants which were treated with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) which was statistically at par with the application of FYM (25kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree) and FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree) which produced the fruits having weight (215.47 and 209.07g respectively). The minimum fruit weight (167.47g) was recorded with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control. This is consistent with the fact that taller plants have more branches, which increases the photosynthetic area. Favourable physiological activities may have increased the production and translocation of photosynthates, which in turn sped up the formation of more fruits with larger sizes and increased fruit yield **(Kumawat *et al*., 2009)**. According to **Panjavarnam*et al.* (2018),** the use of panchagavya may also have increased fruit set while decreasing flower shedding. The fruit output in many crop plants was improved by the increased biological efficiency of the plants due to better chlorophyll synthesis, nutrition availability, and growth-promoting chemicals **(Kumawat *et al*., 2009; Tripathi*etal.*, (2015a)**.

Table 1: Influence of bio-enhancers and bio-fertilizers on physical characteristics of mango fruit

S.No.	Treatments	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (g)	Fruit volume (g/cc)
T_1	FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control	8.30	4.80	167.47	168.90
T_2	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Amritpani (20%) + *Azotobacter* (100g/tree)	9.40	5.48	190.53	193.81
T_3	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree)	10.20	6.15	223.93	238.12
T_4	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter*(100g/tree)	9.60	5.75	209.07	219.67
T_5	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Amritpani (20%) + PSB culture (100g/tree)	9.15	5.35	186.27	188.62
T_6	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree)	9.73	5.90	215.47	227.40
T_7	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB culture (100g/tree)	9.58	5.65	198.33	206.34
SEm±		0.205	0.163	6.246	6.246
CD at 5%		0.605	0.481	18.427	18.427

Fruit volume (cc):

The data related to fruit volume were presented in Table-1 clearly revealed the maximum fruit volume(238.12 cc)was recorded from mango plants treated with FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) which was statistically at par with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree) and FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree)(227.40 cc). The fruitsminimum volume was recorded withFYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control. The results presented here are in agreement withthe findings of **Kumawat**

***et al*., 2009**, which reported that thePanchagavya is an effective and sustainable alternative to conventional NPK fertilization. They also showed a positive impact on vegetative growth and the yield of fruits with the desired quality in mango production. Therefore, the combined use of bio-fertilizer, Panchagavya, and FYM improved the mango's fruiting characteristics because more food material was accumulated in the trees and was used effectively for the production of fruits. **Sau*et al.* (2017), Tripathi *et al.,* (2017)** in strawberry **and Tripathi *et al.,* (2015b)** in aonla.The usage of Panchagavya coupled with FYM and bio-fertilizers resulted in the accumulation of additional food material and its effective utilization for the growth of fruits, which led to the rise in fruit volume.

Peel weight (g)

It was observed that, the minimum peel weight (15.25 g)was recorded with the application of FYM (25 kg/tree/year) + Organic mulch(Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) which was statistically at par with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree) and FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree) which produced peel weight of 15.37g (Table 2). The maximum peel weight (19.33 g)was recorded in fruits that were produced in the plants treated withFYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control. This is well known fact that panchagavyais efficient in enhancing fruit attributes.It is rich in minerals, vitamins, important amino acids, compounds that promote growth like IAA and GA, and some helpful organisms**(Pathak and Ram, 2013)**.Application of bio-fertilizers also affects peel content in banana as reported by**Ganapathi, and Dharmatti (2018)., Nayyer *et.al.* (2014) and Tripathi.**

Pulp weight (g)

The data related to pulp weight presented in Table 2 revealed that, the maximum pulp weight (74.14 g)was recorded in fruits which were produced from the plants treated with the FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) which was statistically at par with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree) and FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree)which produced pulp weight(73.01g). The minimum pulp weight (64.08 g)was recorded in the fruits which were produced from the plants having application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control. This is because

panchagavya,jivamritandamritpani along with bio-fertilizers acts as a potent plant growth stimulant, improve the biological effectiveness of crops, encourage a flurry of biological activity in the soil, and make nutrients readily available to the crop. By applying these organic liquid formulations, soil microbial activity and population were increased to a higher level, which helped with phosphate solubilization, nitrogen fixation, and other processes. Due to the consistent and continuous supply of nutrients during the whole crop growth cycle, this in turn has a favourable impact on growth. These findings were supported by **Tripathi *et al.*(2014)**, **Shubha *et al*. (2014) and Ramesh *et al*. (2015).**

Pulp:Peel ratio:

The data related to pulp: peel ratio presented in Table 2 revealed that, the maximum pulp: peel ratio(5.22)was recorded in mango plants which were treated withFYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) which was statistically at par with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree) and FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree). The minimum pulp:peel ratio (3.48)was recorded with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control. The findings of **Shubha *et al.* (2014) and Ramesh *et al.* (2015),** are in agreement with the present findings.

Table 2: Influence of bio-enhancers and bio-fertilizers on peel weight, pulp weight, peel:pulp ratio and fruit yield of mango.

S.No.	Treatments	Peel weight	Pulp weight	Peel:pulp ratio	Fruit yield
T_1	FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*Control	19.33	64.08	3.48	28.58
T_2	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Amritpani (20%) + *Azotobacter* (100g/tree)	16.76	68.99	4.39	36.64
T_3	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree)	15.25	74.14	5.22	52.84
T_4	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit(20%) + *Azotobacter*(100g/tree)	16.21	71.55	4.80	44.73
T_5	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Amritpani (20%) + PSB culture (100g/tree)	17.77	67.20	4.08	33.56

T_6	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree)	15.37	73.01	5.07	48.55
T_7	FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + PSB culture (100g/tree)	16.47	70.02	4.56	39.93
SEm±		0.401	0.980	0.176	3.032
CD at 5%		1.183	2.893	0.519	8.944

Fruit yield:

It was observed from Table-2 that application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) recorded the maximum fruit yield (52.84 kg/tree)which was statistically at par with the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + PSB culture (100g/tree) and FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Jivamrit (20%) + *Azotobacter* (100g/tree) which produced fruits yield (48.55 kg/tree). The minimum fruit yield (28.58 kg/tree) was recorded in the plants treated with FYM (25 kg/tree/year) + Organic mulch (Paddy straw)*i.e.*,Control. This increase in yield during present experimentation period may be due to the fact that the panchagavya, jivamrit, amritpani and bio-fertilizers have helpful in increasing availability of both major and minor nutrients, as well as they have a variety of microorganisms, particularly bacteria.**Swaminanthan (2005)**reported thatthe presence of naturally occurring beneficial microorganismmostly bacteria, yeast, actinomycetes, and photosynthetic bacteriaimproves plant development, metabolic processes, and resistance to pests and diseases. These microorganisms enhanced the soil ecosystem and increased nutrient availability from source to sink, which may increase the production and quality of the various fruit crops **(Tripathi*et al.*, 2016) and Dutta and Kundu (2012)** found a comparable outcome. The increased fruit yield and fruit output might be linked to higher nutrient levels in the vicinity of the plant area of assimilation, which also accelerated the formation of dry matter and improved the yield through logical distribution to the economic part. The findings of**Tripathi *et al*. (2016), Gupta and Tripathi (2012)**in strawberryand **Tiwari *et al*. (2017), Patil *et al*. (2005), Nayer*et al*. (2014) and Yadav *et al.* (2011), Tripathi (2017)** in banana, and others are in agreement with the result of present findings.

4. Conclusion

From the results of present investigation, it was found that the application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) recorded a significantly higher fruit length, width,weight, volume, pulp weight, pulp:peel ratioand fruit yield. Thus,it can be safely said that application of FYM (25 kg/tree/year) + Organic mulch (Paddy straw) + Panchagavya (3%) + *Azotobacter* (100g/tree) should be made under the sub-tropical plains of Central Uttar Pradesh, India.

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