

**Influence of nitrogen level, vermicompost and
Azotobacter on phenology, yield and quality
attributes of mango (*Mangifera indica* L.) cv.
amrapali under high density planting.**



Thesis submitted to

**BIHAR AGRICULTURAL UNIVERSITY, SABOUR
BHAGALPUR – 813 210
BIHAR, INDIA**

By
VIMLESH KUMAR MAURYA
Regd. No. : D/Hort./016/BAC/2013-14

*IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF*

DOCTRATE OF PHILOSOPHY

in

Horticulture (Pomology)

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Dr. R. R. Singh
Univ. Prof.-cum-Chief
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This is to certify that the thesis entitled “**Influence of nitrogen levels, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango (*Mangifera indica* L.) cv. Amrapali under high density planting**” submitted in partial fulfilment of the requirement for the award of the degree of **DOCTOR OF PHILOSOPHY IN HORTICULTURE (POMOLOGY)**, Bihar Agricultural University, (Sabour), Bhagalpur, Bihar, is genuine record of the *bonafide* research work carried out by **Mr. Vimlesh Kumar Maurya, Reg. No.- D/HORT./016/BAC/2013-14**, under my guidance and supervision. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that such help or information received during the course of this investigation and preparation of the thesis have been fully acknowledged.

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This is to certify that the thesis entitled “**Influence of nitrogen levels, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango (*Mangifera indica* L.) cv. Amrapali under high density planting**” submitted by **Mr. Vimlesh Kumar Maurya, Reg. No.- D/HORT./016/BAC/2013-14**, Bihar Agricultural University, (Sabour), Bhagalpur, Bihar , in partial fulfilment of the requirement for the award of the degree of **DOCTOR OF PHILOSOPHY IN HORTICULTURE (POMOLOGY)** was examined and approved on

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Sabour Bhagalpur
June, 2018

(VIMLESH KUMAR MAURYA)

ABSTRACT

Title of thesis	:	Influence of nitrogen levels, vermicompost and <i>Azotobacter</i> on phenology, yield and quality attributes of mango (<i>Mangifera indica</i> L.) cv. Amrapali under high density planting
Name of student	:	Vimlesh Kumar Maurya
Registration No.	:	D/Hort./016/BAC/2013-14
Degree of Programme	:	Ph.D.
Major Subject	:	Horticulture (Pomology)
Major Advisor	:	Dr. R.R. Singh
Year	:	2018
Name of University	:	Bihar Agricultural University, Sabour, Bhagalpur

Mango (*Mangifera indica* L.) of family Anacardiaceae is one of the most popular fruit of the tropical and sub-tropical region. In recent years high density planting is being promoted due to higher income per unit area. The high density planting is achieved by closer planting of 3.0 m X 2.5m in place of traditional planting distance of 10m×10m using dwarf varieties like Amrapali. The closer planting along with other cultural practices enhance the use efficiency of resources like land, water, fertilizer and solar radiation to its maximum potential. Application of vermicompost and bio fertilizer has been found to be beneficial in different fruit crops. Also, application of inorganic fertilizers like N, P and K are need to be standardize under high density planting. Thus, present investigation was undertaken with the objectives to standardize the nitrogen requirement of mango under high-density planting and to study the effect of levels of nitrogen, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango under high-density planting.

The experiment was laid out in factorial randomized block design with three replications as three factors namely nitrogen, vermicompost and *Azotobacter*. The four levels of nitrogen (60g, 80g, 100g, 120 g/plant), three levels of vermicompost (0 kg/tree, vermicompost @ 4.0 kg/plant and *in-situ* vermicomposting) and two levels of *Azotobacter* (0 g/tree and *Azotobacter* @ 200 g/plant) were taken for the experiment. The maximum fruit set (17.97%) was found with combined application of nitrogen 100 g/tree +

vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree ($N_3 \times V_1 \times A_1$). The heaviest fruit of 203.85 g was found with combined application of nitrogen @ 120 g/tree + *in-situ* vermicomposting along with *Azotobacter* @ 200 g/tree which was statistically equal with nitrogen @ 120g/tree + *in-situ* vermicomposting in the absence of *Azotobacter* and nitrogen @ 120g/tree + vermicomposting @ 4.0 kg/tree in the absence of *Azotobacter*. The highest number of fruits/plant (82.35) was noted with the application of interaction of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg/tree. The plant supplied with nitrogen @ 100 g/tree along with vermicomposting @ 4.0 kg/tree and *Azotobacter* @ 200g/tree ($N_3 \times V_1 \times A_1$), gave the maximum TSS/acidity ratio (185.12), total carotenoid (18.75 mg/100g pulp) and total sugars (18.31 %). Soil health in terms of organic carbon, pH and nutrient content and microbial population improved with the application of nitrogen @ 120g + *in-situ* vermicomposting along with *Azotobacter* @ 200 g/plant.

R.R.Singh
Chairman

Vimlesh Kumar Maurya
Student

ABBREVIATIONS

Abbreviations	Description	Abbreviations	Description
&	- And	J.	- Journal
⁰ C	- Degree centigrade	K	- Potassium
%	- Per cent	K ₂ O	- Potassium oxide
@	- At the rate of	kg	- kilogram
Agric.	- Agricultural	m	- metre
⁰ B	Degree Brix	mg	- miligram
Hort.	- Horticulture	mm	- Milimetre
HDP	- High density planting	mt	- million tonnes
cm	- Centimetre	N	- Nitrogen
CD	- Critical difference	NS	- Non-significant
df	- Degree of freedom	No.	- Number
Ds/m	- Desi simen per meter	O.C.	- Organic carbon
<i>et al.</i>	- Et allii; (Co-authors)	P	- Phosphorus
EC	Electrical conductivity	pH	Potentiality of Hydrogen
<i>Ecol</i>	- Ecology	P ₂ O ₅	- Phosphorus pentaoxide
etc.	- Et cetera (and others)	PSB	Phosphorus solubilizing Bacteria
Fert.	- Fertilizer	qt	- Quintal
Fig.	- Figure	r	- replication
FYM	- Farm yard manure	RDF	Recommended dose of fertilizers
G	- gram	Sci.	- Science
GM	- Green manure	spp.	- species
ha	- Hectare	SEm±	- Standard error of mean
<i>i. e.</i>	- id est (that is)	<i>viz.</i>	- <i>videlicet</i> (namely)
Int.	- International	wt.	- Weight

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Chapter -1

Introduction

Mango (*Mangifera indica* L.) of family Anacardiaceae is one of the most popular fruits of the tropical and sub-tropical region. The chromosome number of mango is $2n = 40$. Mango is considered to be the choicest of all indigenous fruit because of its excellent flavour, attractive fragrance, beautiful shade of colours, delicious taste and healthful value. Mango is now recognized as one of the best fruits in the world market and considered as the king of all fruits. The mango is indigenous to North East India North Burma in the foot hills of the Himalayas and is said to have originated in the Indo-Burma regions. (De Candole, 1904; Popenoe, 1928 and Mukherjee, 1951). It is very well adapted to tropical and subtropical climates and thrives well in almost all the regions of the country from sea level to an altitude of 600 m. The ideal temperature range for mango is 24-30° C during the growing season, along with high humidity. A rainfall range of 890-1,015 mm in a year is considered as ideal for growing mango. However, mango can be grown in regions of both heavy (2540 mm) and scanty (254 mm) rainfall. Dry weather before blossoming is conducive to profuse flowering.

India is the leading producer of mango in world accounting more than 50% of total production worldwide. Currently, mango is cultivated in an area of 2263.0 thousand hectares with a total production of 19687 thousand MT in India. The average productivity is 8.7 metric tonnes per hectare (NHB, 2017). While its area, production and productivity in Bihar are 1450.64 thousand hectares, 1479.58 thousand MT and 9.82 metric tonnes per hectares, respectively (NHB, 2017).

Mango is a prized summer fruit crop of India with over one thousand recognized varieties consumed as fresh fruit or in the form of processed products. The unripe mango fruits are used for making pickles, preserves, aamchur, chutneys and other culinary preparations. In addition to direct consumption of the ripe fruit mango slice, pulp juice, squash, jam, mango papad are also preserved and canned for use out of season. Beside rind kernel and seed have their own uses. The ripe fruit contains good amount of nutrients viz., protein (0.69%), fat (0.19%), fibres (1.10%), carbohydrates (11.6%), vitamin B₁ (40 mg/100g), vitamin C (6.8 mg/100g) etc.

Mango is generally planted at wide distance of 10 m x 10 m accommodating 100 plants / ha. But in recent years high density planting is being promoted due to shrinking cultivable land to accommodate more and more plants per unit area using dwarf varieties. Mango variety Amrapali is the most suited under high density planting due to its dwarf

structure. Under high density plantation resource like land, water, fertilizer and solar radiation are utilized to its maximum potential.

Region wise nutritional requirement of mango plant has been standardized by different workers. But nutrient management for high density planting of mango is very less known. The role of nutrient elements either alone or in combination with other sources (organic manures/Fertilizers/bio-fertilizers) has been well established in many fruit crops including mango.

The mango is relatively tolerant of low soil fertility, consequently an adequate supply and uptake of nutrients gives a good response in plant growth and nutrient export to the fruit. Nitrogen is one of the most important nutrients for the growth of mango and it has a relevant role in the production and quality of the fruits. Its effects are seen principally in the vegetative phase of growth, and considering the relationship that exists between vegetative and reproductive flushes (development of floral buds and fruit formation) nitrogen deficiency may adversely affect yield. Mangoes adequately nourished with nitrogen regularly develop shoots, which when they reach maturity have viable panicles able to bear fruit. Lack of nitrogen causes retarded development, less vegetative growth and reduced production of fruit. Excess of nitrogen causes excessive vegetative growth, difficulty at floral differentiation, loss of yield and fruit quality, and an increased susceptibility to malady.

Vermicompost a by-product of earthworm mediated organic waste recycling is rich in plant nutrients and growth promoting substances (Reddy and Ohkura, 2004). It is finely divided peat-like materials with high porosity, aeration, drainage, and water-holding capacity and contain nutrients in forms that are readily taken up by the plants. Application of vermicompost in combination with NPK fertilizers resulted in higher content of total nitrogen compared to FYM in combination with NPK fertilizers (Kale *et al.* 1992). Vermicomposting is a process of bio transforming and stabilizing organic materials (often waste) into humus by the combined activity of earthworms and microorganisms (Aira and Dominguez, 2008). Now a days bio fertilizer likewise used as one of the nutrient components of integrated nutrient management in different fruit crops.

Azotobacter spp. are non-symbiotic heterotrophic free-living nitrogen-fixing bacteria. *Azotobacter* habitually fixes molecular nitrogen from the atmosphere without symbiotic relations with plants, capable to fixing an average 20 kg N/ha/per year (Kizilkaya, 2009). Bacterization helps to improve plant growth and to increase soil nitrogen through nitrogen fixation by utilizing carbon for its metabolism.

There is a large potential to increase mango production in India, However, due to problems of diseases and pest infestation and poor nutritional and orchard management. The quality and yield of mango could not achieve to complete in domestic and export market.

Therefore, present investigation is undertaken to evaluate the **“Influence of nitrogen levels, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango (*Mangifera indica* L.) cv. Amrapali under high density planting”** with following objectives:

Objective of the investigation are-

- To standardize the nitrogen dose for mango under HDP.
- To study the impact of different levels of nitrogen, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango under HDP.
- To study the impact of different levels of nitrogen, vermicompost and *Azotobacter* on nutrient status of soil and leaf.



Chapter - 2

Review of Literature

Mango (*Mangifera indica* L.) is one of the most popular fruit of the tropical and sub-tropical regions. It is the national fruit of India having the maximum area and production in the world. Bihar is the fifth largest producer of mango.

Inorganic fertilizers are one of the most expensive inputs in orchard management. Besides, continuous application of huge amount of chemical fertilizers hampers the yield, quality and soil health. As such, it is necessary that fertilizer application should be made in balanced through inorganic and organic sources along with bio fertilizer. A review of available literature was done and being systematically illustrated under the following heads.

2.1. Phenological observations

Ram and Nagar (2004) reported that increasing vegetative growth like plant height (80.51 m) with recommended dose of fertilizers, basal girth (0.043 m) with BD 500, plant spread (east-west, 109.0 m) with CPP and plant spread (North-South, 0.92) with the application of vermicompost of guava tree cv. Sardar.

Ram *et al.* (2007) conducted a research on organic production of guava cv. Allahabad Safeda. The result examined that the highest nutrient levels (N, P, K, Ca and S) of guava leaf from November sampling varied from 1.61 to 2.66, 0.13 to 0.17, 0.60 to 1.89, 0.74 to 0.94, 0.17 to 0.20 per cent respectively absorbed with the combine application of different organic sources (FYM 20kg + CPP 500g/ plant)

Athani *et al.* (2009) opined that *In-situ* vermi-composting increased pseudostem height, girth, number of functional leaves, leaf area and leaf area index in banana cv. Rajapuri.

Osman and Rhman (2010) conducted an experiment to investigate the combined effects of organic manure and bio N-fertilization on growth, productivity of fig tree. The result examined that poultry manure + *Azotobacter* and poultry manure + *Azospirillum* gave the highest number of new shoot, shoot length, leaf area, total chlorophyll and leaf minerals (N,P, K, Ca and Mg %) content.

Gautam *et al.*, (2012) conducted an experiment to study the effect on integrated plant nutrient management in mango cv. Sunderja. The result exposed that the maximum plant

height, canopy height, plant spread (N-S) and (E-W) as well as tree volume were recorded with the application of 500g N: 250 g P: 250 g K /tree + 50 kg FYM + 10 kg vermicompost.

Binepal *et al.* (2013) noticed that the application of 100% N (600 g) + 100% P₂O₅(400 g) + *Azospirillum* (30 g) + PSB (30 g) + 10 kg vermicompost, significantly influenced the morpho-physical characters in terms of plant height (0.65 m), canopy spread N-S (0.92 m) and E-W (1.00 m) in guava.

Patil and Shinde (2013) conducted a research on integrated nutrient management on growth and yield of banana cv. Ardhapuri. The result examined that maximum plant height (190.84 cm) and plant girth (81.34 cm) were recorded in treatment 50% RDF + FYM + *Azotobacter* (50g/plant) + PSB (50 g/plant) + VAM (250 g/plant) while the maximum leaves (32.30)per plant and leaf area (17.93 m²) were recorded with the application of 50% RDF + FYM + *Azotobacter* (50 g/plant) + PSB (50 g/plant) + VAM *Glomus fasciculatum* (250 g/plant).

Khehra and Bal (2014) found that application of FYM (2 times the standard dose viz. 150 Kg/tree) + inorganic fertilizer (1.5 times the standard dose viz. 525g/tree) + *Azotobacter* (18g/tree) proved to be most effective in improving plant height of lemon cv. Baramasi.

Ram *et al.*(2014) noticed that maximum leaf nutrition like N (1.68 %), P (0.244 %), K (1.74 %), Ca (1.49 %), Zn (33.8 %), Mg (0.63 %)with the application of rhizospheric soil of *Ficus bengalensis* @ 250 g/tree + 5 % *Amritpani* + organic mulching, whereas highest Mg (0.63 %) content was found with the application of vermicompost (30 kg/tree) + *Azospirillum culture* (250 g/tree) +PSB (5 g/tree) in guava tree cv. Sardar.

Thakur and Thakur (2014) reported that combined application of 75% NPK + bio-fertilizers (60 g each/tree basin) + green manuring with sunhemp @ 25 g seeds/tree basin significantly produced highest annual shoot growth (55.27 cm), tree height (4.98 m), and tree volume (18.62 m³) however the highest trunk girth (71.47 cm) and leaf area (13.12 cm²) were observed with 50% NPK + bio-fertilizers (60g each/tree basin) + green manuring with sunhemp @ 25 g seeds/tree basin + FYM (40 kg) + vermicompost (11.5 kg).

An experiment was carried by Dutta *et al.* (2016) out with organic manures, inorganic manures and bio-fertilizers alone and in combination on mango cv. Himsagar.

The Results revealed that the bio-fertilisers (*Azotobacter* + PSM) along with 50% inorganic fertilizer significantly increased the growth characters of mango trees.

Humin Xiang *et al.* (2017) reported that in-situ earthworm breeding enhanced the all growth parameter over whole growth period in papaya as compared to chemical fertilizer and compost.

2.2. Flowering and fruiting behaviour, yield parameter and fruit yield

Sharma *et al.* (2000) conducted an experiment, Studies on the fertilizer requirements of mango cv. Dashehari. They observed the highest fruit yield with application of 800 g N + 200 g P + 300 g per tree per year.

Satapathy and Banik (2002) noted that application of 100 g each of N, P, and K per plant per year markedly increased the number of fruits/plant, yield and pulp content of mango cv. Amrapali.

Ahmad *et al.* (2003) found that application of 145g of nitrogen per plant along with 15 g of *Azotobacter chroococcum* CBD was increased yield of Amrapali mango under high density planting.

Ghosh and Bauri (2004) reported that application of N 300g, P 200 g, K 200g and organic manure 40 kg per tree per year increase fruit weight and fruit yield of mango cv. Himsagar.

Ram and Nagar (2004) reported that combined application of FYM 20 kg per plant + *Azotobacter* 250 g/plant improved yield (92 fruits/plant and 13.69 kg/plant) of newly established plant of guava cv. Allahabad Safeda.

Tarai and Ghosh (2006) conducted an experiment on effect of different levels of nitrogen on fruit weight, size and quality of pineapple cv. Kew grown as intercrop in the mango orchard. They found that the highest fruit weight, size and yield with the application of 18 g N/plant/year.

Athani *et al.* (2007) reported that maximum fruit weight (221.0 g), fruit volume (218.50 ml) and pulp thickness (2.33 cm) and its weight (143.0 g) were found with application of 75 per cent recommended dose of fertilizers (RDF) + vermicompost @ 10 kg/plant, however, the plants receiving 50 worms/plant recorded maximum yield (29.10 kg/plant and 8.10 t/ha) in guava cv. Sardar.

Naik and Babu (2007) noted that application of 25 kg/tree resulted in highest fruit yield, however, more number of fruits/shoots and per cent fruit drop was nil with combined application of sheep, goat and leaf litter in guava cv. Sardar.

Madhavi *et al.* (2008) reported that application of 1000 g each of NPK/tree/year increase yield of 5 year old mango tree cv. Banganapalli.

Osman and Rhman (2010) Reported that poultry manure + *Azospirillum* gave the highest number of fruit per shoot, fruit length, fruit volume and yield, in fig tree.

Barne, *et al.* (2011) Conducted an experiment on effect of integrated nutrient management on yield and quality of Guava. The result revealed that combined application of 487.5+243.75+281.25 g NPK + 50 kg FYM + 250 g *Azotobacter* + 250 g PSB/plant/year was showed the highest yield (39.45 kg/plant).

Baviskar *et al.* (2011) noted that the fruit yield in terms of number of fruits harvested per plant, fruit yield (kg/plant) was recorded maximum with the application of 1125:750:375 g NPK + 15 kg vermicompost + 250 g *Azotobacter* + 250 g PSB/plant in sapota.

Singh and Banik (2011) observed that application of NPK (500g. +250 g. +250g per plant) + FYM (50 kg.) + *Azospirillum* (250g.) per plant retained more number of fruit per panicle at marble stage and highest fruit weight in mango variety Himsagar.

Yadav *et al.* (2011) found that recommended dose of NPK(500 + 250 + 250 g./plant) + FYM (30 kg/plant) + vermincomposting (30 kg/plant) + *Azotobacter* (250 g/plant) + PSB(250 g/plant) + Zn (40 % spray) + paclobutazol (5 ml/plant) produce maximum panicle length, fruit/ panicle in Amrapali mango.

Devi *et al.* (2012) found that application of FYM 26 kg + *Azotobacter* 100 g + phosphorous solubilizers 100 g + potash mobilizers 100 g/plant/year enhanced the yield (114 kg/plant) of four-year-old guava tree cv. Sardar.

Gautam *et al.*, (2012) reported that maximum number of fruit per panicle, largest fruit and consequently maximum yield with the application of NPK (500g + 250 g + 250 g) + FYM (50 kg) + Vermicomposting (10 kg) in Sunderja mango.

Reddy *et al.* (2012) reported that highest fruit weight (589.2 g plant⁻¹) of papaya cv. Surya observed with the application of 75% recommended dose of fertilizers applied through FYM + vermicompost + *Azospirillum* + Mycorrhiza.

Sarker and Rahim (2012) found that the maximum fruit weight and yield with application of cow dung (37.5 kg) + Urea (1125 g) + TSP (600g) + MOP (375 g) + ZnSO₄ (22.5 g)/plant on Amrapali mango.

Singh *et al.* (2012) round that application of 75 kg FYM + 500: 250: 300 g NPK/plant/year maximized the yield (32.15 kg) of aonla cv. NA-7.

Binepal *et al.* (2013) conducted an investigation on integrated approach for nutrient management on seven year old guava tree cv. L-49 under Malwa Plateau conditions of Madhya Pradesh. The result revealed that the yield parameters in terms of maximum fruit length (7.52 cm), diameter (7.91 cm), volume (217.41 ml), fruit setting (79.56%), the minimum fruit drop (20.41%), maximum fruit retention (79.59%), average fruit weight (220.37 g) and number of fruits per tree (384) influenced with the application of 100% N (600 g) + 100% P₂O₅(400 g) + *Azospirillum* (30 g) + PSB (30 g) + 10 kg vermicompost.

Dhaker *et al.* (2013) conducted a field experiment on the effect of farm yard manure and boron on growth and yield of bael. The results revealed that application 50 kg FYM + Borax 6 per cent increase fruit weight (971.83 g), number of fruit (23.0) and fruit yield (20.40 kg).

Dhomane and Kadam (2013) revealed that integration of organic manures and inorganic fertilizers was more effective in increasing yield and quality of guava trees than the inorganic fertilizers. Combined application of, 75% nitrogen through urea along with 25% nitrogen through neem cake was found the best over most of the treatments in respect of yield parameters like weight of fruit (243.80 g), yield per tree (58.1 kg) and yield per hectare (23.26 tons).

Kumar and Kumar (2013) reported that the maximum number of fruit and yield where found in Dashehari mango with application of vermicompost 75 kg/pant.

Navaneethakrishnan *et al.*(2013) studied that fertilizer treatment consisting of 200 g N in 5 split doses and 60 g P₂O₅increased the fruit characteristics like bunch weight, number of hands per bunch, hand weight and number of fingers per hand as well as yield of 'Grand naine' banana.

Patil and Shinde (2013) revealed that application of 50% RDF + FYM + *Azotobacter* (50 g/plant) + PSB (50 g/plant) + VAM *G. fasciculatum* (250 g/plant) was found beneficial for yield of banana (bunch weight 19.31 kg/plant and per hectare (85.80 t/ha)) cv. Ardhapuri.

Rajendra *et al.* (2013) noted that the application of FYM (8.31 t/ha) + vermicompost (4.16 t/ ha) + 75% recommended NPK increased the fruit length (4.69 cm), fruit girth (4.37 cm), peel thickness (1.170 mm), fruits/plant(1284.33), yield (15.41 t/ha) of acid lime cv. Kagzi.

Sharma *et al.* (2013) observed that application 25% of N per tree through FYM + 75% of N per tree through inorganic fertilizer showed maximum fruit length(8.39 cm), breadth(7.94 cm), weight(244.24 g) and consequently highest yield(41.14 kg/plant) of 15 years old winter season guava cv. Sardar.

Adak *et al.* (2014) found that application of 10 kg vermicompost, bio-fertilizers (*Azotobacter* + PSM + *Trichoderma harzianum*) and organic mulching showed significantly improvement in yield (45.4 kg/tree) of Sweta guava.

Behera *et al.* (2014) conducted an experiment on with and without application of bio-fertilizers to study the impact of intercrops and bio-fertilizer on growth and yield characteristics of mango cv. Amrapali. The result examined that growing of intercrops like ginger, turmeric and pineapple with bio-fertilizers and inorganic fertilizers gave maximum mango yield was recorded intercropping with turmeric with application of bio-fertilizers (36.87 q/ha) followed by intercropping with ginger with application of bio-fertilizers (34.47 q/ha).

Dutta *et al.* (2014) reported that combined application of *Azospirillum*+ *Azotobacter* + VAM was improved the yield (6.95t/ha) of guava cv. L-49.

Garhwal *et al.* (2014) conducted an experiment on effect of organic manure and nitrogen on growth yield and quality of kinnow mandarin. The results revealed that the application of 80 kg farm yard manure per plant significantly increased fruit yield (25.22 kg/tree), number of fruits (212.75fruits/tree), average fruit weight (118.22 g), fruit diameter (5.96 cm), fruit length (5.58 cm), volume of fruit (129.71 cc), peel weight (32.95 g), weight of sacs (85.27 g), juice percentage (48.30%).

Lal and Dayal (2014) found that application of 50 per cent RDF through inorganic source viz N 250: P 150: K 150g + remaining 50 per cent through goat manure performed best with fruit length(4.43 cm), weight(35.71 g), diameter(3.99 cm)and consequently yield(7.58 kg/tree) of acid lime.

Nasreen *et al.* (2014) reported that the highest yield and yield attributes of mango cv. BARI Aam-1 were recorded under application of N960 g: P200 g: K300 g: S110 g/tree.

Ram *et al.* (2014) conducted an experiment on compare the efficacy of different organic inputs in the production guava cv. Allahabad safeda and concluded that the highest number of fruit (363 plant⁻¹) and yield (41.45 kg/plant) were recorded with the combine application of 250 g rhizospheric soil of *Ficusbengalensis* + 5 per cent of *Amritpani* + organic mulching.

Shukla *et al.* (2014) observed that application on vermicompost, bio-fertilizers and organic mulching resulted in highest yield of guava.

Thakur and Thakur (2014) revealed that 50% NPK + bio fertilizers (Azotobacter, AMF, PSB) 60g each/tree basin+ green manuring (Sunhemp @ 25 g seeds/tree basin) + 40 kg FYM + 11.5 kg vermicompost improved the fruit set(77.28%) and fruit yield(28.11 kg/tree) of plum cv. Santarosa.

Hazarika *et al.* (2015) recorded that 100% RDF + mycorrhiza (AM) + *Azospirillum* + PSB + *Trichoderma harzianum* improved the superiority in yield attributing characters like hands per bunch(10.20), fingers per hand(22.87), fingers per bunch(187.00), weight of second hand(3.76 kg), bunch weight(24.42 kg) and yield (75.35 t/ ha) of Banana cv. Grand Naine.

Sharma *et al.*(2016) found that 50% N through poultry manure + 50% N through urea showed maximum fruit length(8.47 cm),breadth(8.02cm), weight(248.80 g), pulp weight(218.68 g) and consequently the highest fruit yield(42.89 kg/plant) of sixteen year old guava tree cv. Lucknow- 49.

Athani and Hulamani, N.C. (2000) reported that the 100 % of RDF gave the maximum yield per hectare in the both plant and ratoon crop over in-situ vermicomposting in banana cv. Rajapuri.

Prakash *et al.* (2010) reported that the application of 2 kg Urea + 5 kg SSP+2 kg S.O.P. + 450 g each ZnSO₄, CuSO₄ and Borax along vermicompost 40 kg/plant/year produced highest yield of mango cv. Langra.

Gupta and Tripathi (2012) revealed that the plant getting *Azotobacter* @ 6 kg/ha + vermicompost maximum number fruit set in strawberry cv. Chandler.

Gupta and Tripathi (2012) an experiment was carried out in the Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India. Study the efficacy of *Azotobacter*, vermicompost alone and in combination on flowering of strawberry cv. Chandler. There were nine treatments comprising two levels each of *Azotobacter* (6 and 7 kg/ha) and vermicompost (20 and 30 t/ha) and their

combinations along with one control. All the doses of *Azotobacter* and vermicompost were applied at the time of planting in the field. The data of both the years of experiment were analyzed which clearly showed that the combined application of *Azotobacter* at 7 kg/ha + vermicompost at 30 tonnes/ha significantly took the minimum number of days taken to produce first flower.

Mayadevi, *et al.* (2014) an investigation was carried out under subtropical conditions of West Bengal. The number of fruits and fruit yield per tree were greater with vermicompost + *Azotobacter* + phosphorous solubilizers + potash mobilizers in litchi cv. Bombai.

2.3. Quality parameters of fruit

Ram and Nagar (2004) noted that application of vermicompost 5 kg/tree maximized the TSS (11.20 °B) while ascorbic acid 242.40 mg/100g with Biodynamic treatment (BD500) of newly established plant of guava cv. Allahabad Safeda.

Athani *et al.* (2007) conducted an experiment on the influence of vermicompost on variation in growth parameters, fruit characters, quality and yield of 5 year old guava cv. Sardar. The result revealed that TSS (10.83 °B), ascorbic acid (208.60 mg/100g) and total sugars (8.62%) were higher with the application of 75 per cent RDF + 10 kg vermicompost plant⁻¹ followed by the *In-situ* application of vermiculture at 50 worms/plant and 100 per cent RDF per plant.

Naik and Babu (2007) conducted an experiment on feasibility of organic farming in guava the results revealed that TSS was found highest with animal manures, ascorbic acid content was highest in pig manure, whereas total sugars and reducing sugars were maximal with goat manure.

Barne *et al.* (2011) noticed that application NPK 487.5:243.75: 281.25 g + 50 kg FYM + 250 g *Azotobacter* + 250g PSB/plant significantly improved fruit quality in terms of total soluble solids (12.510B), total sugar (8.70%) and minimum acidity (0.259%) of guava.

Baviskar *et al.* (2011) Noted that application of NPK 1125:750:375 g + 15 kg vermicompost + 250 g *Azotobacter*/ plant + 250 g PSB/plant showed superior fruit quality terms of highest total soluble solids and total sugar with lower acidity in sapota.

Devi *et al.* (2012) Reported that treatment combinations with poultry manure(10 kg/plant/year) + *Azospirillum* (100g/plant/year) + phosphorous solubilizers (100g/plant/year) + potash mobilizers (100g/plant/year) showed the highest total soluble solids (12°Brix) and total sugar(6.67%), content whereas the vitamin C (172.6 mg/100 g pulp) content was recorded maximum by application of neem cake (9 kg/plant/year) in guava cv. Sardar.

Goswami *et al.* (2012) noted that application of half dose recommended fertilizers viz. 225g N: 195g P: 150g K + 50 kg FYM enriched with *Azospirillum* 250 g/tree/year significantly increased the fruit quality of five year old guava plant cv. Pant Prabhat.

Reddy *et al.* (2012) conducted a field experiment on effect of organic practices on fruit quality in papaya cv. Surya. The result examined that the application of 50% recommended dose of fertilizers in the form of farm yard manure(FYM) applied as *Azospirillum* + PSB + *Mycorrhiza* + Vermicompost showed high level of carotenoids (7.54 mg/100g), lycopene (5.03 mg/100g), whereas highest ascorbic acid content (1190.33mg/100g) recorded with 50% recommended dose of fertilizers applied as FYM + vermicompost.

Binepal *et al.* (2013) applied two levels of nitrogen *i.e.*, 600 g N (100% N) and 450 g N (75% N), two levels of phosphorus *i.e.*, 400g P₂O₅ (100% P₂O₅) and 300 g P₂O₅ (75% P₂O₅) and a common dose of potassium *i.e.*, 300 g K₂O and 30 g each of *Azospirillum* and PSB inoculation and 10 kg Vermicompost in seven year old guava tree cv. L-49. The result revealed that fruit quality parameters in terms of maximum TSS (11.67 °Brix), total sugar (8.06%), reducing sugar (4.17%), non-reducing sugar (3.89%), pectin (0.81%), ascorbic acid (207.90 mg/100 g pulp) and minimum acidity (0.20%) were obtained with the application of 100% N + 100% P₂O₅+*Azospirillum* + PSB + 10 kg vermicompost.

Dhaker *et al.* (2013) reported that combined effect of FYM (100 kg/tree) was found significant pertaining to gain in quality parameters like TSS (32.49 B⁰), sugar (18.15 %) and ascorbic acid (17.56 mg/100g) of Bael.

Sharma *et al.* (2013) Reported that *Azotobacter* + 50% of N/tree through FYM + 50% of N/tree through inorganic fertilizer showed highest TSS (12.950B⁰), total sugars (8.61%) and minimum physiological loss in weight (14.29%) after ten days under ambient conditions of 15-year old winter season guava cv. Sardar.

Sharma *et al.* (2013) examined that application of *Azotobacter* + 50% of N/ tree through FYM + 50% of N/tree through inorganic fertilizer significantly improved the biochemical character like TSS (12.97 °B), total sugars (8.65 per cent) of guava cv. Sardar.

Dutta *et al.* (2014) observed that maximum TSS (9.20B⁰), total sugar (7.77 %) and ascorbic acid (167.22 mg/100 g pulp) were obtained from plants treated with *Azospirillum*+ *Azotobacter* + VAM. of guava tree cv.-L49.

Garhwal *et al.* (2014) reported that application of 80 kg of FYM per plant increased fruit quality with regard to TSS (12.11 °B), ascorbic acid (26.37 mg/100 g edible portion), total sugar (6.63%), reducing sugar (2.92%), non-reducing sugar (3.71%) and significantly minimum juice acidity (0.79%) of kinnow mandarin.

Lal and Dayal (2014) conducted an investigation on effect of integrated nutrient management on yield and quality of acid lime. The result examined that maximum juice (43.37%), TSS (10.42%) and ascorbic acid (86.33 mg/100 g juice) content and minimum seed (1.15%) and acidity (6.06%) content were found with application of 50% RDF through inorganic fertilizer + 50% through Goat manure.

Mayadevi, *et al.* (2014) noted that the treatment combinations with farm yard manure + *Azotobacter* + phosphorous solubilizers + potash mobilizers showed higher total soluble solids and total sugar content whereas vitamin C content was higher a combination of neem cake + *Azospirillum* + phosphorous solubilizers + potash mobilizers in litchi cv. Bombai.

Ram *et al.* (2014) Maximum TSS (11.17 °B) was recorded through application of biodynamic compost fortified with BD 500 (30 kg/tree) cow pat pit 100 g/tree of guava cv. Allahabad Safeda

Hazarika *et al.* (2015) conducted an experiment on Conjunctive use of bio-fertilizers and organics for improving growth, yield and quality of banana cv. Grand Naine. The result examined that significantly highest ascorbic acid (10.03 mg/100g), TSS (22.64⁰B), total (18.75%), reducing (9.33%) and non-reducing (9.43%) sugars as well as sugar: acid ratio (76.10%) and lowest moisture (70.91%), titrable acidity (0.25%) content were maximized with combined use of organic, inorganic and biological sources of nutrients (100% RDF + AM + *Azospirillum* + PSB + *T. harzianum*).

Dutta *et al.* (2016) the physico-chemical character of mango cv. Himsagar was improved by bio-fertilisers (*Azotobacter* + PSM) along with 50% inorganic fertilizer

significantly improved the fruit quality, viz. total soluble solids, total sugar and β -carotene. Similarly Lal and Dayal (2014) reported that application of 50 % RDF + 50 % goat manure produced quality fruits of acid lime.

Sharma *et al.* (2016) found that application of *Azotobacter* + 50% N/tree through FYM + 50% N/tree through inorganic fertilizer showed highest TSS (13.01°B), total sugars (8.68%) and minimum physiological loss in weight (13.20%) after 10 days during storage under ambient conditions in guava cv. L-49.

Humin Xiang *et al.* (2017) reported that *in-situ* earthworm breeding enhanced the TSS, sugars and Vitamin C over whole growth period in papaya as compared to chemical fertilizer and composting.

2.4. Nutrient content in leaf

Bhattarai and Tomar (2009) conducted an experiment on effect of integrated nutrient management on leaf nutrient status of walnut the results revealed that application of recommended dose of NPK ((750: 375: 750g/plant) +50 kg vermicompost improved leaf nitrogen (2.78 %) and phosphorus (0.31%) status of walnut.

Goswami *et al.* (2012) conducted field experiment on effect of bio-fertilizers enriched in FYM along with half-dose of recommended fertilizers on five- year- old guava plants of cv. Pant Prabhat. The result revealed that half dose of recommended fertilizers (225g N: 195 g P: 150 g K) + 50 kg FYM enriched with *Azospirillum* 250g/tree/year found most effective to increase the vegetative growth of plants and maximum leaf N and K in the leaf tissue, however maximum leaf P content was recorded in treatment consisting of half dose of recommended fertilizers + 50kg FYM + *Trichoderma* (250 g) + *Pseudomonas fluorescens* (250g).

Sharma *et al.* (2013) an experiment was conducted to find out the effect of organic and inorganic sources of fertilizers on yield, quality and nutrient status of winter season guava. The data revealed that highest soil nitrogen and phosphorous (269.97 & 19.77 kg/ha), Ca & Mg (7.03 & 2.76 meq/ 100 g soil) respectively, was obtained with the treatment comprising *Azotobacter* + 25% of N/tree through FYM + 75% of N/tree through inorganic fertilizer, whereas, the highest soil potassium (148.23 kg/ha) contents was obtained with the application of *Azotobacter* + 50% of N/tree through FYM + 50% of N/tree through inorganic fertilizer.

Dutta *et al.* (2014) conducted an investigation was carried out to study the effect of bio-fertilizers on physico-chemical qualities and leaf mineral composition of guava cv. L-49. The result revealed that the application of *Azotobacter* + *Azospirillum* + VAM demonstrated maximum nitrogen (1.49%), phosphorus (0.42%) and potassium (1.52%) content in leaves.

Khachi *et al.* (2015) Recorded that application of FYM @ 15 kg/vine, green manuring, vermicompost @ 15kg/vine, bio-fertilizer @ 50-g/ vine and vermi-wash at 2kg/vine significantly improved amounts of leaf macro and micronutrients viz. N (2.49%), P (0.26%), K (1.48%), Fe (208.0 mg/kg), Cu (17.8 mg/kg), Zn (36.2 mg/kg) and Mn (88.3 mg/kg) in kiwi fruit.

Sharma *et al.* (2016) reported that application of *Azotobacter* + 50% N in consequence of poultry manure + 50% N by mean of urea increased leaf N and P (1.78 and 0.16%), Ca and Mg (2.09 and 0.91%) contents, respectively, on dry weight basis, while highest leaf K (1.27% on dry weight basis) contents were recorded with the application of *Azotobacter* + 75% N through poultry manure + 25% N by mean of urea in guava cv. L-49.

Marthe *et al.* (2012) stated that application of FYM along with 50% dose of inorganic fertilizer & green manuring of sunhump along with 50% dose of inorganic fertilizers and found the highest concentration of N (2.19%), P (0.111), K (1.38%) & micronutrient in the leaves of sweet orange.

Dutta *et al.* (2010) reported that application of organic manure, bio-fertilizer along with inorganic fertilizer had significant effect on leaf mineral content & also recorded maximum leaf N & K content with maximum microbial population in litchi orchard.

2.5. Soil fertility and microbial population status

Bhandari *et al.* (1992) found that organic carbon content of soil increased significantly with application of 100 per cent RDF(NPK). The conjunctive use of organic manures such as FYM or green manure with fertilizer further increased the organic carbon content of soil.

Vasanthi and Kumaraswamy (1999) revealed that the application of poultry manure or sheep/goat manure @10 t t/ha along with 50 per cent RDF significantly increased organic carbon content soil as compared to only inorganic fertilizers in red clay loam soil.

Ram *et al.* (2007) noticed that microbial population in rhizosphere soil of three year old guava trees improved after the application of different organic sources. The bacterial count was maximum (8.1×10^6 cfu/g soil) with application of FYM 20kg+BD-500,

whereas, it was minimum with the application of FYM 20 kg+250g *Azotobacter* (6.1×10^5 cfu /g soil).

Devi *et al.* (2012) conducted an experiment on effect of different organic and bio-fertilizer sources on guava cv. Sardar. The result showed that application of nutrients through organic along with bio-fertilizers improved soil health in terms of mean microbial population in the rhizosphere of root zone soil as compared to control.

Singh *et al.* (2012) conducted an experiment on influence of organic and inorganic nutrient sources on soil properties and quality of aonla in hot semi-arid ecosystem. The result examined that soil parameters in terms of pH (7.15), EC (0.14dS/m), bulk density (1.41 mg/m), available N (220.15kg/ha), P (24.18 kg/ha), K (124.15 kg/ha) significantly improved with the application of FYM + standard dose of NPK, while organic carbon (6.3 g/kg) was also improved significantly by neem cake + FYM + CPP.

Adak *et al.* (2014) conducted a field research on assessing soil characteristics and guava orchard productivity as influenced by organic and inorganic substrates. The result examined that significantly higher microbial population (bacteria, fungi and *Actinomycetes*) was recorded with the application of vermicompost + bio-fertilizers + mulching.

Mayadevi, *et al.* (2014) application of nutrients through organic source along with Bio-fertilizers improved soil health by increasing the microbial population in the rhizosphere in litchi cv. Bombai.

Sharma *et al.* (2016) conducted an investigation on impact of poultry manure on fruit quality attributes and nutrient status of Guava cv. L-49. The result revealed that the highest soil organic carbon (0.72%) was obtained with the combined application of *Azotobacter* + 100% N through poultry manure, while soil N and P (271.36 and 19.86 kg/ha), Ca and Mg (7.12 and 2.82 meq 100/g soil), respectively, were found maximum with the application of *Azotobacter* + 50% N through poultry manure + 50% N through urea, however, highest soil K (148.53 kg/ha) contents were recorded with the application of *Azotobacter*+ 75% N through poultry manure + 25% N by mean of urea.



Chapter - 3

Material and Methods

The present investigation entitled “**Influence of nitrogen levels, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango (*Mangifera indica* L.) cv. Amrapali under high density planting.**” was carried out in the Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural College, Sabour, Bhagalpur, Bihar during 2014-15 and 2015-16. The brief description of the materials used, experimental procedure followed and techniques adopted during the study are described in this chapter.

3.1 Geographical situation of experimental site

The field experiment was conducted at Horticulture Garden, Sabour, at permanent experimental site of the Bihar Agricultural College, Sabour, Bhagalpur (Bihar Agricultural University, Sabour). The experimental site falls are the heart of the vast alluvial Gangetic plains of North India, south of river Ganga having well drained and irrigated sandy loam soil of good fertility with leveled surface and lies between 25°15'40" N latitude, 87°2'42" E longitude with an altitude of 46 m from mean sea level.

3.2 Weather

The climate of Sabour is semi-arid, subtropical with hot desiccating summer, cold but frost less winter with an average annual rainfall of about 1150 mm precipitating mainly in between middle of June to middle of October. Mainly three seasons influences the agricultural activities of this region, these are winter season (November to February), summer season (March to June) and rainy season (Mid June to October).

Monthly distribution of rainfall, temperature (maximum and minimum), relative humidity, wind velocity and monthly rainy days during the crop period have been presented in Appendix-Ia and 1b and depicted in Fig. 3.a and 3.b during 2014-15 and 2015-16, respectively.

Table 3.1: Meteorological observation at experimental site Bihar Agricultural College, Sabour, Bhagalpur (BAU, Sabour) during September, 2014 to July, 2015

Month	Tmax ($^{\circ}$ C)		RH (%)		Rain (mm)	Wind velocity	Monthly rainy days
	Max.	Min.	7:00 AM	2:00 PM			
September, 2014	32.5	23.7	88.0	76.0	131.5	3.9	16.0
October, 2014	32.2	20.2	86.0	67.0	3.2	2.0	2.0
November, 2014	29.0	14.3	85.0	49.0	0.0	1.4	0.0
December, 2014	21.5	9.1	94.0	67.0	0.4	2.7	1.0
January, 2015	20.6	8.8	91.0	67.0	0.4	3.8	2.7
February, 2015	26.5	11.4	93.0	67.0	39.3	2.5	3.6
March, 2015	30.6	16.3	88.0	57.0	4.7	4.7	6.3
April, 2015	32.5	19.4	77.0	52.0	22.0	5.9	6.1
May, 2015	36.1	24.2	80.0	52.0	70.9	6.9	6.9
June, 2015	35.0	25.8	76.0	54.0	27.2	7.7	5.9
July, 2015	32.4	25.2	80.0	65.0	176.5	6.1	4.6

Table 3.2: Meteorological observation at experimental site Bihar Agricultural College, Sabour, Bhagalpur (BAU, Sabour) during August, 2015 to July, 2016

Month	Tmax ($^{\circ}$ C)		RH (%)		Rain (mm)	Wind velocity	Monthly rainy days
	Max.	Min.	Max.	Min.			
August, 2015	32.2	25.6	88.0	76.0	271.7	4.1	4.5
September, 2015	32.7	24.8	90.0	78.0	353.3	2.3	5.4
October, 2015	28.4	14.6	89.0	73.0	243.7	0.7	6.2
November, 2015	28.7	15.1	86.0	59.0	11.4	0.5	3.7
December, 2015	23.5	9.5	90.0	61.0	0.0	0.5	1.4
January, 2016	22.4	7.6	89.0	66.0	0.0	0.8	0.4
February, 2016	27.1	10.7	95.0	61.0	24.4	0.1	1.3
March, 2016	32.3	18.4	88.0	49.0	3.4	0.1	3.4
April, 2016	38.6	21.4	82.0	44.0	2.4	0.8	7.6
May, 2016	35.2	23.1	68.0	35.0	23.2	3.4	9.3
June, 2016	34.1	25.5	84.0	68.8	3.8	3.8	7.9
July, 2016	31.9	25.5	89.6	79.9	10.0	10.0	8.1

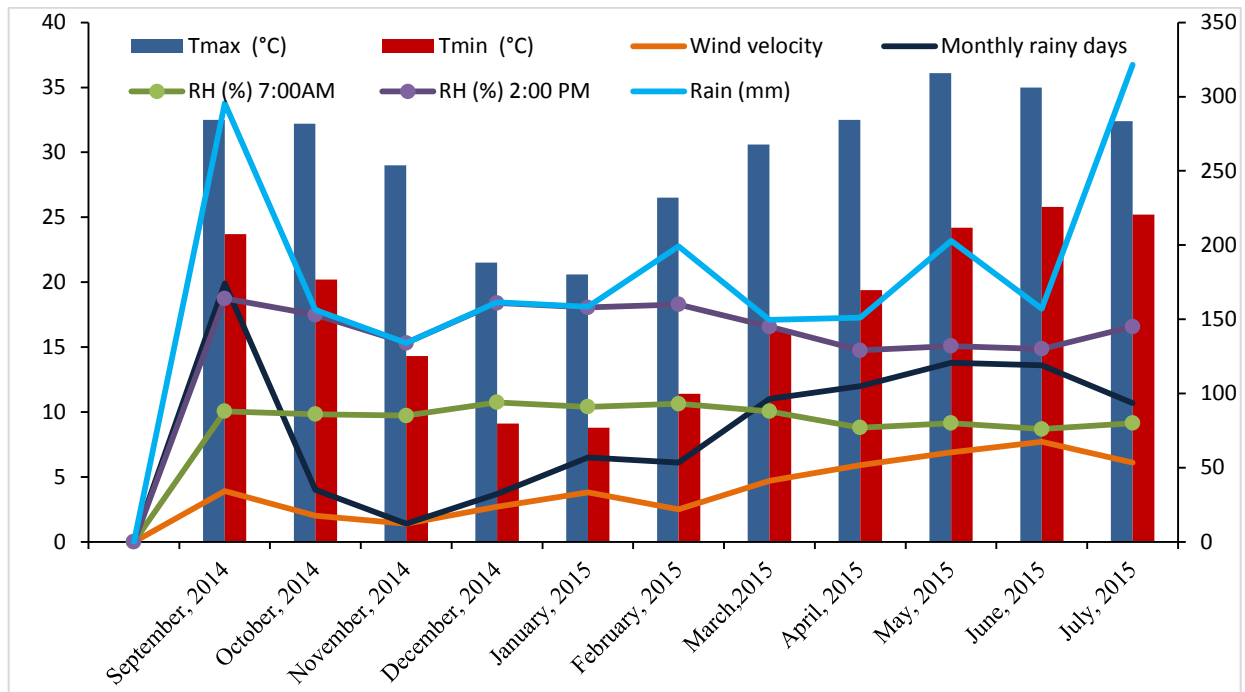


Fig. 3a: Meteorological observation at experimental site BAC, Sabour, Bhagalpur during 2014-15

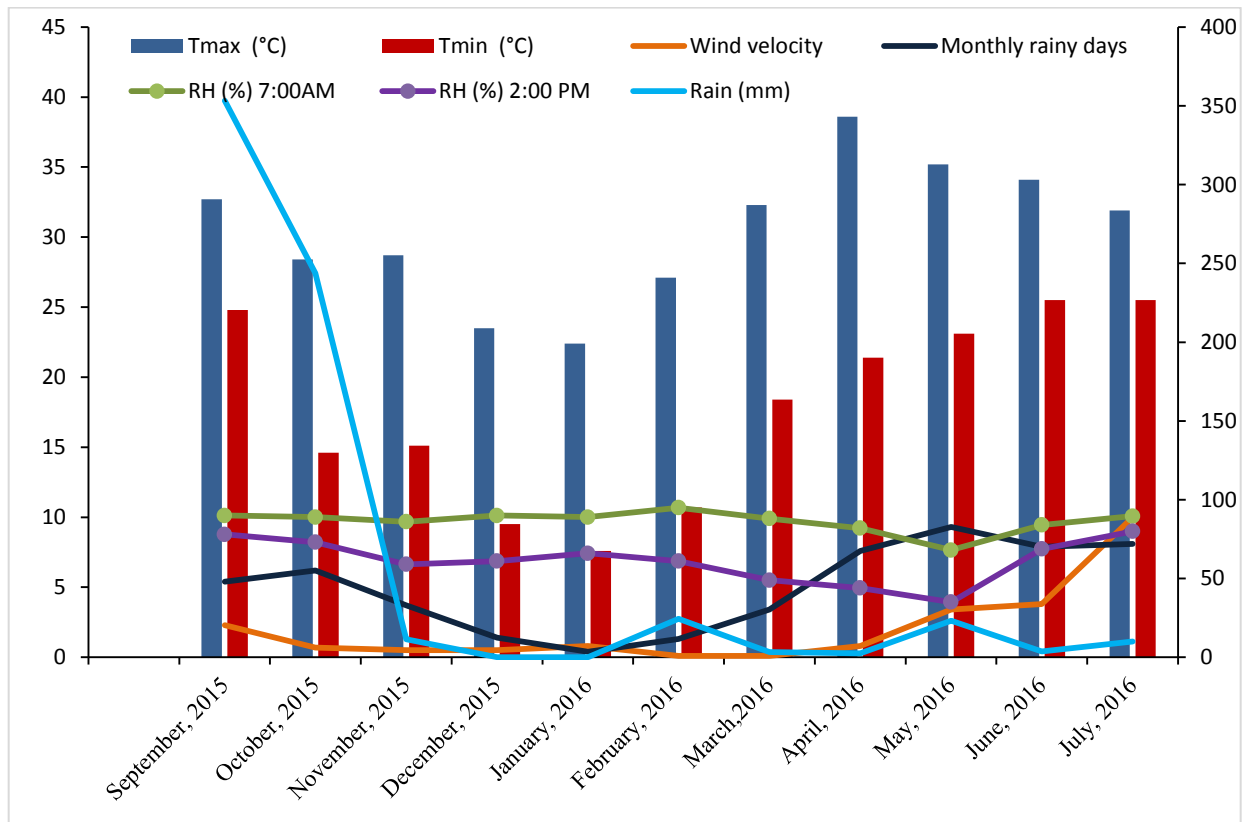


Fig. 3b: Meteorological observation at experimental site BAC, Sabour, Bhagalpur during 2015-16

3.3. Soil of the experimental plot

Soil of the plot where experimental trees were grown is Indo-Gangetic alluvial in origin. The land was fairly levelled. The soil was fair in texture and medium in fertility level. A composite soil sample of the experimental plot was collected from surface and sub surface horizon (0-30, 30-60 and 60-90 cm) twice *i.e.* prior to experiment conduct and after harvesting of fruit. The source of irrigation was tube well.

3.4 Detail of the experiment

3.4.1 Treatments

There were twenty four treatment combinations as detailed below.

A. Levels of Nitrogen

1. N_1 - 60 g/plant
2. N_2 - 80g/plant
3. N_3 - 100 g/plant
4. N_4 - 120 g/plant

B. Levels of Vermicompost

1. V_0 – Without Vermicompost
2. V_1 – 4 kg Vermicompost/plant
3. V_2 – In situ vermicompost equivalent to 4 kg/plant

C. Levels of *Azotobacter*

1. A_0 – Without *Azotobacter*
2. A_1 – *Azotobacter* 200 g/plant

Table 3.3: Treatment combination

$T_1 - N_1 V_0 A_0$	$T_7 - N_2 V_0 A_0$	$T_{13} - N_3 V_0 A_0$	$T_{19} - N_4 V_0 A_0$
$T_2 - N_1 V_0 A_1$	$T_8 - N_2 V_0 A_1$	$T_{14} - N_3 V_0 A_1$	$T_{20} - N_4 V_0 A_1$
$T_3 - N_1 V_1 A_0$	$T_9 - N_2 V_1 A_0$	$T_{15} - N_3 V_1 A_0$	$T_{21} - N_4 V_1 A_0$
$T_4 - N_1 V_1 A_1$	$T_{10} - N_2 V_1 A_1$	$T_{16} - N_3 V_1 A_1$	$T_{22} - N_4 V_1 A_1$
$T_5 - N_1 V_2 A_0$	$T_{11} - N_2 V_2 A_0$	$T_{17} - N_3 V_2 A_0$	$T_{23} - N_4 V_2 A_0$
$T_6 - N_1 V_2 A_1$	$T_{12} - N_2 V_2 A_1$	$T_{18} - N_3 V_2 A_1$	$T_{24} - N_4 V_2 A_1$

Note: RDF - N: P_2O_5 : K_2O = 60:30:40 g/Plant (Dose of P_2O_5 and K_2O will be same in all treatment)

3.4.2 Experimental design:

The experiment was laid out on Randomized Block Design (Factorial) under field condition. Numbers of replication were three with 1 plants in each replication.

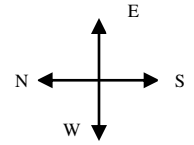


Fig. 3c: Layout plan of the experiment

N1V0A0	N2V2A1	N1V1A0	N4V2A1	N3V0A0	N2V1A1	N3V0A1	N4V2A0	N3V1A01	N2V2A0	N1V0A1	N4V1A1
T1	T12	T3	T24	T13	T10	T14	T23	T15	T11	T2	T22
N3V1A1	N2V0A1	N3V2A0	N2V1A0	N1V2A1	N4V0A1	N1V2A0	N4V1A0	N3V2A1	N4V0A0	N1V1A14	N2V0A0
T16	T8	T17	T15	T6	T20	T5	T21	T18	T19	T4	T7
N1V0A1	N4V1A1	N1V0A0	N2V2A1	N1V1A0	N4V2A1	N2V1A1	N3V0A1	N4V2A0	N3V1A01	N2V2A0	N3V0A0
T2	T22	T1	T12	T3	T24	T10	T14	T23	T15	T11	T13
N4V1A0	N3V2A1	N4V0A0	N1V1A14	N2V0A0	N3V1A1	N2V0A1	N3V2A0	N2V1A0	N1V2A1	N4V0A1	N1V2A0
T21	T18	T19	T4	T7	T16	T8	T17	T9	T6	T20	T5
N3V0A0	N1V1A0	N4V2A1	N2V1A1	N2V2A1	N3V0A1	N3V1A01	N2V2A0	N1V0A1	N4V1A1	N4V2A0	N1V0A0
T13	T3	T24	T10	T12	T14	T15	T11	T2	T22	T23	T1
N3V2A1	N2V0A0	N3V1A1N	N1V2A1	N4V0A0	N4V1A0	N1V2A0	N2V1A0	N3V2A0	N4V0A1	N1V1A1	N2V0A1
T18	T7	T16	T6	T19	T21	T5	T9	T17	T20	T4	T8

} 3 m

2.5 m

3.4.3 Experimental Details

Design	Factorial Randomized block design (RBD)
Replication	Three
Number of treatment combination	Twenty four
Plants/replications	One
Total number of plants	72
Crop	Mango
Cultivar	Amrapali
Age of tree	Five year old
Planting Distance	3.0 m X 2.5 m

All the nutrient sources will be applied as basal dose except nitrogen. Nitrogen was be applied in two split doses, *i.e.* 50 % nitrogen, as basal dose during September month and remaining 50 % was applied after fruit set during April month.

3.5 Observations recorded

3.5.1 Soil Parameter:

Soil samples were collected from the tree basin at different vertical depth of 0-30 cm, 30-60 cm and 60-90 cm during investigation after fruit harvest. Soil sample was thoroughly mixed and divided in equal portions, a portion samples were air dried at room temperature and processed through a 2.0 mm sieve and homogenate examined for chemical analysis (pH, Electrical conductivity, available nitrogen, available phosphorus and available potassium) other half fresh moist soil was used for microbiological study (Total bacteria, fungi and *Azotobacter*). It was stored under refrigeration (at 4°C).

Different media were used for chemical analysis as stated below.

S.No.	Particular	Methods	Reference
1	pH (1:2.5 soil water suspension)	Beckman glass Electrode Method	Jackson, 1967
2	Soil Ec (1:2.5) dS/m at 25°C	Electrical conductivity bridge (1:2.5 soil water suspension)	Jackson, 1967
3	Organic carbon (%)	Walkley and Black Method	Jackson, 1967
4	Available N (kg/ha)	Alkaline KMnO ₄ Method	Subbiah and Asija, 1956
5	Available P ₂ O ₅ (kg/ha)	Olsen's Method	Watanabe and Olsen 1965
6	Available K ₂ O (kg/ha)	1N neutral ammonium acetate Method	Jackson, 1967

3.5.2 Microbial population estimation

The enumeration of the microbial population was done by dilution plate technique (Allen, 1957). The plates were incubated 30±2°C. The counts were taken at 5th and 7th day of incubation. The result were reported as number of cells per gram of soil as average of triplicates. Different media were used for bacteria, fungi and *Azotobacter* as stated below.

S. No.	Particular	Media	Reference
1	Total Bacteria	Thorton's medium	Thornton, 1922
2	Fungi	Peptone dextrosrose Bengal agar medium	Martin, 1950
3	<i>Azotobacter</i>	Nitrogen Deficient Medium	Abd-el-malek and Ishac, 1968

3.5.3 Phenological observations of mango

3.5.3.1 Vegetative Growth

3.5.3.1.1 Percent increase in plant height

The plant height was measured in meter from ground surface to top of the tree vertically with the help of measuring tape along with bamboo pole during both the year at the initiation of experiment and after fruits harvest.

3.5.3.1.2 Percent increase in plant spread

Two bamboo poles were kept vertically straight touching the side of the canopy of the each tree on East-West the distance between the two poles was measured in meters with the help of measuring tape. The canopy spread was also measured in North-South direction in the same way and then average of E-W and N-S spread was calculated.

3.5.3.1.3 Canopy volume:

It was measured by calculating E-W and N-S canopy spread and height of the plant with the help of measuring tape, using the formula as given by Roose *et al.* (1986). The net increment in tree canopy volume was calculated by subtracting the initial tree canopy volume to the final volume reported after harvest during both the experimental years.

$$V=4/6\pi r_2h$$

Where, h= height of tree (m), r= (Sum of E-W and N-S direction (m))/4

3.5.3.4. Leaf nutrient status

Leaf samples at maturity stage (July) from each treatment were harvested for nutrient analysis. The data was recorded for macro nutrient (NPK) contents. The methodology for nutrient analysis was as mentioned below.

3.5.4.1. Sample preparation

The samples were first washed with tap water to remove the adhered dust and soil particle. Then, they were decontaminated using 0.2 % Teepol solution, 0.1 N HCl and double distilled water in a series. This was followed by drying in a forced draft hot air oven ($70\pm1^\circ\text{C}$) until a constant weight was reached. The dried samples was then ground and passed through 1 mm sieve and stored in airtight containers.

3.5.4.2. Nitrogen

500 mg of the oven dried samples was taken in 250 ml Kjeltex tubes. 3.9 g digestion mixture containing 3.5 g K_2SO_4 and 0.4 g CuSO_4 was added to it and digested with 12 ml

concentrated H₂SO₄ on the digestion unit 2020 and 2000, digestion system. The digested samples were distilled and total nitrogen was determined by KEL PLUS - Kjeldhal nitrogen analyzer.

Digestion of plant material: Tissue samples were wet digested with a diacid mixture of concentrated nitric acid and perchloric acid (9:4 v/v). 15 ml of diacid mixture was added to 500 mg of the prepared samples and pre-digested at a temperature of 100°C for an hour and at 250°C until the solution turned colourless and the volume reduced to 2-3 ml. The digested material was then diluted and filtered through Whatman No. 1 filter paper and volume was made up to 100 ml. The filtrate obtained was used for the estimation of phosphorus and potassium.

3.5.4.3. Phosphorus

Phosphorus was estimated by vanado-molybdate colour reaction method. To the 5 ml of the above aliquot taken into 50 ml volumetric flask, 10 ml vanado-molybdate reagent was added and volume made up to the mark. Per cent transmittance at 420 nm was measured with the help of spectrophotometer. Phosphorus concentration was estimated by plotting the transmittance value against standard value on a semi log paper. Per cent P of the samples was calculated using the P concentration.

$$P (\%) = \frac{\text{Sample concentration (ppm)} \times \text{Final volume (ml)} \times 100}{\text{Weight of Sample(g)} \times \text{Aliquot} \times 1000}$$

3.5.4.4. Potassium

Potassium content was determined by a microprocessor based flame photometer using specific filter (K filter) and LPG flame. The different standard K solutions (5, 10, 20 to 100 ppm) were atomized to standardize the instrument. Suitably diluted diacid digest was then fed to an atomizer capillary tube and concentration was directly read on the display monitor. Percent K content on dry weight basis was calculated.

3.5.5 Flowering Behaviour

3.5.5.1 Time of panicle initiation/emergence

The date of appearance of first panicle was recorded on the tagged branches by visiting the experimental orchard every day during the time of panicle emergence.

3.5.5.2 Flowering date

It was recorded by visiting the experimental orchard every day after panicle emergence and the number of days was counted from the date of panicle emergence to the day when 50 per cent flowers appeared on a panicle were opened.

3.5.6 Fruiting Behaviour

3.5.6.1 Fruit set percentage

The total number of fruit set on the selected panicles was counted after completion of flowering. The percent of fruit set was calculated from the total number of flowers previously recorded.

$$\text{Fruit set (\%)} = \frac{\text{No. of fruits at initial stage}}{\text{No. of flowers in panicle}} \times 100$$

3.5.6.2 Fruit drop (percentage)

The per cent fruit drop was recorded with the same tagged branch of the plant on which fruit set percent was studied. The per cent fruit drop was calculated with the help of following formula

$$\text{Fruit drop (\%)} = \frac{\text{No. of fruits at initial stage} - \text{No. of fruit retained at harvest}}{\text{No. of fruits at initial stage}} \times 100$$

3.5.6.3 Fruit retention (percentage)

The final fruit retention per cent was recorded similar procedure as that for fruit drop was followed. Fruit retention on selected branches was recorded at harvesting stage and per cent value was calculated with following formula-

$$\text{Fruit retention (\%)} = \frac{\text{Number of fruits retained till maturity}}{\text{Initial number of fruit set}} \times 100$$

3.5.7 Physical parameters of fruit

3.5.7.1 Fruit weight

The fruit weight was noted with the five randomly selected fruits of each treatment of all three replications which were weighed carefully by electronic balance in gram and the average fruit weight was calculated with dividing five.

3.5.7.2 Fruit length

The same five fruits which were taken for weight of each treatment of all three replication take for measurement of length by Varnier calliper and presented as cm.

3.5.7.3 Fruit width

The same five fruits were taken to measure the width. The width was also measured by Varnier calliper and presented as cm.

3.5.7.4 Fruit volume

After recording the observations with respect to fruit size and weight, fruit volume was determined by water displacement method and the average volume of fruit expressed as cm³.

3.5.7.5 Specific gravity

Specific gravity of fruit was determined by dividing the weight of fruit by its volume was previously recorded.

$$\text{Specific gravity of fruit} = \frac{\text{Weight of fruit (g)}}{\text{Volume of the fruit (cm}^3\text{)}}$$

3.5.7.6 Pulp weight

The pulp weight of fruit derived by deducting the total weight of stone and total weight of peel from the whole weight of fruit and which was calculated as –

$$\text{Pulp weight (g)} = \text{Weight of whole fruit} - (\text{Weight of stone} + \text{Weight of Peel})$$

3.5.7.7 Peel weight

Peel weight of fruit derived by deduction of pulp and stone weight of fruits from whole fruit weight.

$$\text{Peel weight (g)} = \text{Weight of whole fruit} - (\text{Weight of stone} + \text{Weight of pulp})$$

3.5.7.8 Pulp:stone ratio

The pulp stone ratio of fruits was calculated pulp weight dividing by stone weight.

3.5.7.9 Pulp:peel ratio

The weight of pulp and peel of the fully ripened sample fruit was recorded and dividing the pulp weight by peel weight.

3.5.7.10 Number of fruits and yield

The yield of fruits per plant was recorded by counting of the harvested fruits in each treatment. Yield was calculated by monthly number of fruits and average weight of fruit, expressed as kg/tree

3.5.8 Biochemical and antioxidant compounds

3.5.8.1 Total soluble solids (TSS)

Fruits were randomly selected from each treatment and macerated for juice. Total soluble solid (TSS) in the juice were determined by using of digital hand Refract-meter 0-32 per cent range. The values were corrected at 20⁰C and expressed as ⁰B TSS in fruit pulp.

3.5.8.2 Titratable acidity:

The acidity was determined by diluting the known volume of clean juice, filtered through muslin cloth with distilled water and titrated against standard N/10 sodium hydroxide (NaOH) solution, using phenolphthalein as an indicator. The appearance of light pink colour was marked as the end point. The result was expressed in terms of per cent acidity of the fruit juice (A.O.A.C., 1990).

$$\text{Acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times 64 \times \text{Volume made up} \times 100}{\text{Aliquot taken} \times \text{weight of sample} \times 1000}$$

3.5.8.3 TSS/Acid ratio

It was calculated by dividing the TSS with total acidity and results was expressed in per cent.

3.5.8.4 Total sugars (%)

Total sugars were determined by Lane and Eynone (1923) methods. 10 g of fruit pulp was grinded using pestle and mortar and transfer in a 250 ml volumetric flask. In this flask, volume was made about 100 ml with distilled water and added 2.0 ml lead acetate solution and 1.9 ml of potassium oxalate solution after that make up the volume 250 ml with distilled water. There after filtered the sample through filter paper. Took 50ml of filtrate solution in 100ml volumetric flask and added 5.0 ml concentrated HCl and kept it for 24 hours. There after adding 2 drops of phenolphthalein indicator added 40% NaOH solution until pink colour appear. After that added N/10 HCl drops wise, until pink colour disappeared. Then made the volume with distilled water, take this solution in burette. Then 5.0 ml each of Fehling's solution A and B were taken in a conical flask and added 50 ml distilled water in it. Boil the solution until it becomes colourless. Then added 2 drops of Methylene blue indicator and titrate it with filtrate solution until brick red end point appears.

$$\text{Total Sugar (\%)} = \frac{\text{Factor} \times \text{Dilution} \times 100}{\text{Titre value} \times \text{Weight of Sample}}$$

3.5.8.5 Total carotenoids content

Total Carotenoids content of mango fruit pulp was determined by the method of Roy (1973) with some modifications. In which 5.0 g of pulp was crushed in acetone till the tissue became colourless. Then the extracted solution was poured into a separating funnel. Petroleum ether and small amount of sodium sulphate solution were added and shaken rigorously. Then the separating funnel was kept undisturbed to separate the carotenoids from acetone to petroleum ether layer. After that, coloured solution was separated in a 50 ml volumetric flask and the volume was adjusted with petroleum ether. Finally, the sample absorbance was measured at 452 nm against petroleum ether using 1.0 cm cuvette in a (HALO DB-20S UV-VIS double beam) spectrophotometer. The results were expressed as mg /100 g fresh weight of pulp basis.

$$\text{Total Carotenoids content } \left(\frac{\text{mg}}{100\text{g}} \right) = \frac{3.87 \times \text{O.D} \times \text{volumes made up}}{\text{Weight of Sample} \times 1000} \times 100$$

3.5.8.6 Ascorbic acid content:

The ascorbic acid of fruit juice was determined by diluting the known volume of juice with 3% metaphosphoric acid and titrating with 2, 6 dichlorophenol indophenol dye solution. The result was expressed as mg of ascorbic acid per 100 g of fruit juice (A.O.A.C., 1990).

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{volume up}}{\text{Aliquot taken} \times \text{Weight of Sample}} \times 100$$



Chapter - 4

Results

The results of present investigation entitled “**Influence of nitrogen levels, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango (*Mangifera indica* L.) cv. Amrapali under high density planting.**” obtained pertaining to plant growth, yield and quality attributes, soil fertility status and soil microbial analysis have been presented in tables and illustrated graphically wherever necessary. Data on different characters under study were put to statistical test of significance and the analysis of variance for various characters has been given in Appendix II.

4.1 Main effects

4.1.1. Effect of nitrogen, vermicompost and *Azotobacter* on phenological observations:

Data pertaining to phenological observations (plant height increased, plant spread N-S, plant spread E-W and canopy volume) as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been presented in Table 4.1 and graphically represented in Fig.4.1

A perusal of pooled data indicates that the each increasing levels of nitrogen brought significant improvement towards increasing plant height (%). The maximum increase in plant height (29.22 %) was noted with application of nitrogen @ 120 g/ tree (N_4), which showed most superiority over remaining levels of nitrogen. The minimum increase in plant height (18.63 %) was noted with the application of nitrogen @ 60 g/ tree (N_1).

The vermicompost also showed the significant effect on per cent increase in plant height. The highest increase in plant height (25.42 %) was observed with in- situ vermicomposting (V_2) followed by vermicomposting @ 4kg/tree and without vermicomposting (V_0).

The *Azotobacter* caused the significant effect on percent increase of plant height. The application *Azotobacter* @ 200 g/tree (A_1) recorded significantly maximum (22.95%) increase in plant height, whereas, the minimum increased in height (22.24 %) was noted when the *Azotobacter* was absent. (A_0).

Plant canopy spread in north-south direction significantly increased with increasing levels of nitrogen from 60 to 120 g/tree during both the years. On the basis of pooled data, 14.71% plant canopy spread (N-S) was noted with the application nitrogen @ 120 g / tree (N_4), which was found significantly superior over rest levels of nitrogen (*i.e.* 60, 80 and 100 g/tree).

Table 4.1: Effect of nitrogen, vermicompost and *Azotobacter* on vegetative growth of mango cv. Amrapali under HDP

Treatment	Plant Height increased (%)			Plant Spread N-S (%)			Plant Spread E-W (%)			Canopy volume (m ³)		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	17.34	19.92	18.63	8.71	10.93	9.82	8.05	9.49	8.77	8.92	9.77	9.34
Nitrogen @80g/tree (N ₂)	18.46	21.13	19.79	9.66	13.14	11.40	9.10	11.12	10.11	10.25	11.13	10.69
Nitrogen @100g/tree (N ₃)	21.82	23.67	22.74	11.73	14.55	13.14	11.22	12.89	12.05	11.10	12.35	11.72
Nitrogen @120g/tree (N ₄)	28.64	29.80	29.22	13.21	16.21	14.71	12.49	14.35	13.42	11.89	14.13	13.01
SEm_±	0.36	0.47	0.30	0.19	0.22	0.14	0.21	0.29	0.18	0.22	0.31	0.19
CD (P=0.05)	1.02	1.34	0.83	0.53	0.63	0.41	0.60	0.83	0.51	0.62	0.87	0.53
Vermicompost level												
vermicomposting 0 kg/tree (V ₀)	19.39	21.80	20.59	9.56	12.21	10.88	9.04	10.62	9.83	9.29	10.52	9.91
vermicomposting 4.0 kg/tree (V ₁)	20.56	23.00	21.78	10.62	13.57	12.09	10.00	11.78	10.89	10.16	11.11	10.63
In-situ vermicomposting (V ₂)	24.75	26.09	25.42	12.30	15.35	13.82	11.60	13.47	12.54	12.17	13.91	13.04
SEm_±	0.31	0.41	0.26	0.16	0.19	0.12	0.18	0.25	0.16	0.19	0.27	0.16
CD (P=0.05)	0.89	1.16	0.72	0.46	0.54	0.34	0.52	0.72	0.44	0.54	0.76	0.48
<i>Azotobacter</i> level												
<i>Azotobacter</i> 0g/tree (A ₀)	21.08	23.40	22.24	10.61	13.47	12.04	9.99	11.73	10.86	10.40	11.85	11.13
<i>Azotobacter</i> 200g/tree (A ₁)	22.05	23.85	22.95	11.05	13.95	12.50	10.44	12.19	11.31	10.67	11.84	11.26
SEm_±	0.25	0.33	0.21	0.13	0.16	0.10	0.15	0.21	0.13	0.15	0.22	0.13
CD (P=0.05)	0.72	NS	0.59	0.38	0.44	0.29	0.43	NS	0.36	NS	NS	NS

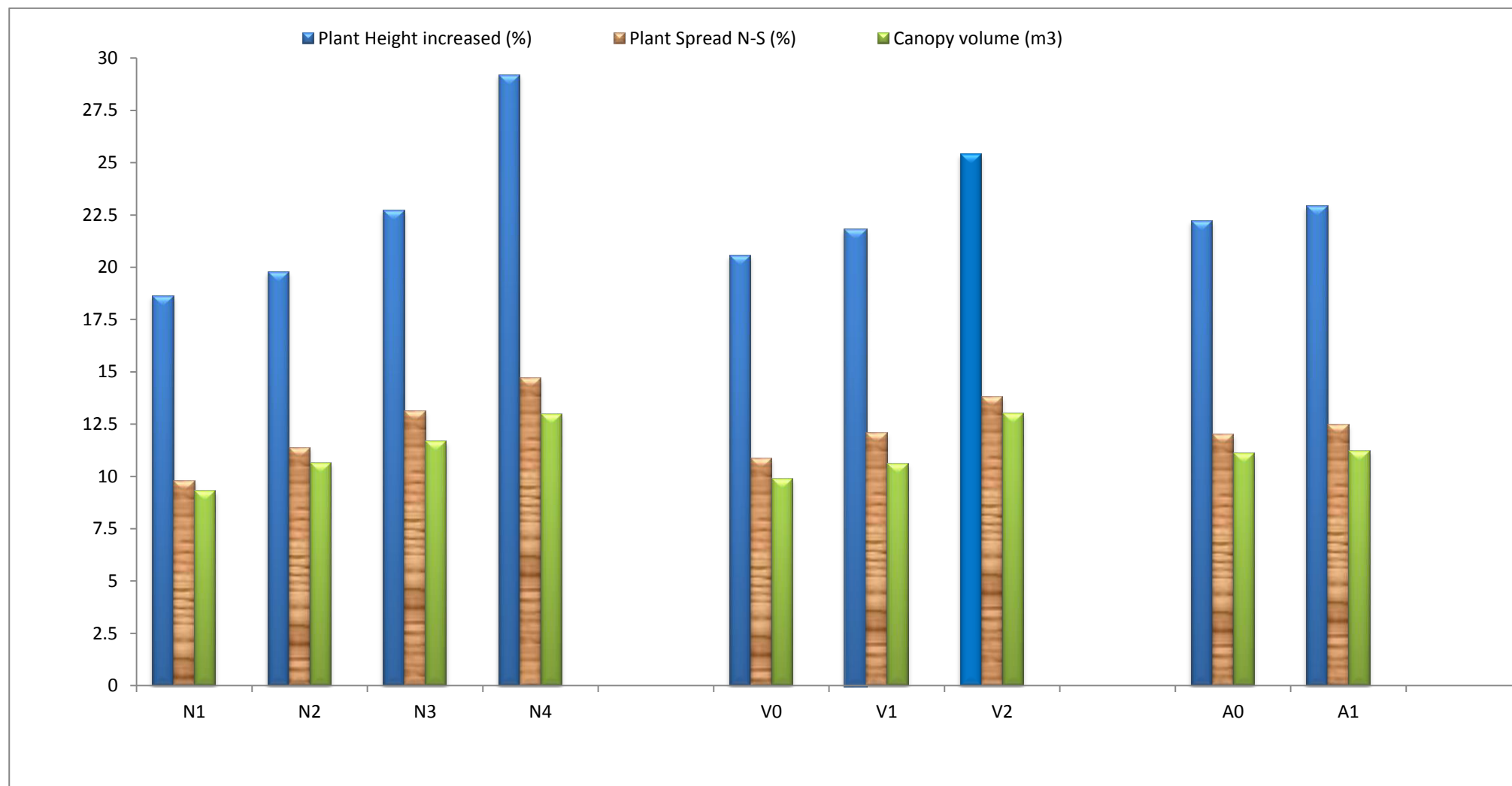


Fig.4.1: Effect of nitrogen, vermicompost and *Azotobacter* application on plant height, plant spread and canopy volume of mango cv. Amrapali under HDP

The effect of vermicompost also showed significant impact towards increasing plant canopy spread (N-S). The maximum increase (13.82 %) in (N-S) plant canopy spread was noted with the application of *In-situ* vermicomposting. The lowest increase (10.88 %) in (N-S) plant canopy spread was observed under the treatment without use of vermicompost.

The perusal of data revealed that the plant canopy spread in north-south direction significantly increased with increase in the levels of *Azotobacter* from zero to 200g/tree during both the years. On the basis of pooled data significantly maximum (12.50 %) increase in plant canopy spread (N-S) was noted with the application of *Azotobacter* @ 200g/tree (A_1), while minimum (12.04 %) was obtained in the absence of *Azotobacter* (A_0).

Plant canopy spread in east-west direction significantly increased with increasing levels of nitrogen during both the years. According to pooled data over two years, the maximum plant canopy spread in east-west direction was increased with the application of nitrogen @ 120 g / tree (N_4) i.e. 13.42%, which was significantly superior over all remaining levels of nitrogen. The minimum increase i.e. 8.77 % in plant canopy spread (E-W) was obtained with the plants raised under nitrogen level of 60 g / tree (N_1)

The data accumulated on account of canopy spread (E-W) as influenced by the application of vermicompost was found to be significant. On the basis of pooled data, the plant getting *In-situ* vermicomposting produced significantly highest canopy spread in east-west direction (12.54%), which was significantly higher than that of vermicomposting @ 4 kg/tree (V_1) and plant grown without Vermicomposting (V_0). However, the lowest (9.83%) increase in canopy spread (E-W) was recorded in that plant grown without vermicompost (V_0)

The application of *Azotobacter* brought significant variation in canopy spread in east-west direction. Pooled data indicated that the maximum (11.31%) significant increase in canopy spread in east-west direction was recorded with the application of *Azotobacter* @ 200 g/tree. Whereas, the minimum increase (10.86 %) in canopy spread in east-west direction was noted under the treatment without *Azotobacter*.

Data indicated that the each successive levels of nitrogen (60-120g/plant) significantly increased the plant canopy volume during both the years as well as pooled over two years. The plant receiving nitrogen @ 120 g/tree (N_4) attained significantly maximum percent canopy volume increase (13.01%), which was significantly superior to all remaining doses of nitrogen. The minimum per cent canopy volume increase (9.34%) was obtained with the plant receiving nitrogen @ 60 g/tree (N_1).

It was noticed that the application of vermicompost brought significant variation with respect to increase in plant canopy volume. The plant getting *In-situ* vermicompost produced significantly higher canopy volume increase (13.04 %), which was significantly superior over V_1 (vermicompost @ 4 kg/tree) and V_0 (without vermicompost). Lowest plant canopy volume increased (9.91 %) was recorded in plant grown without vermicompost (V_0).

The main effect of *Azotobacter* did not cause any significant variation in canopy volume increase.

4.1.2. Effect of nitrogen, vermicompost and *Azotobacter* on fruiting behaviour

Data recorded on account of fruit set, fruit drop, fruit retention and fruit weight as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been given in Table 4.2 and graphically illustrated in Fig. 4.2.

The highest fruit set (17.04% and 17.07%) was noted with the application of nitrogen @ 100 g/tree (N_3) during both the years, respectively, which showed most superiority with rest of the levels of nitrogen. The lowest fruit set (9.15% and 9.18%) was counted with application of nitrogen @ 60 g/tree (N_1). The pooled data also showed the similar trends. During 2014-15, the highest fruit set (13.95%) was noted in the application of vermicompost

Table 4.2: Effect of nitrogen, vermicompost and *Azotobacter* on fruiting behaviour of mango cv. Amrapali under HDP

Treatment	Fruit set (%)			Fruit drop (%)			Fruit retention (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen level									
Nitrogen @60g/tree (N ₁)	9.15	9.18	9.17	94.88	91.52	93.20	5.12	8.47	6.80
Nitrogen @80g/tree (N ₂)	12.72	12.74	12.73	92.99	90.48	91.73	7.01	9.52	8.27
Nitrogen @100g/tree (N ₃)	17.04	17.07	17.06	91.05	89.37	90.21	7.71	12.36	10.03
Nitrogen @120g/tree (N ₄)	15.58	15.61	15.59	92.29	87.64	89.97	8.95	10.69	9.82
SEm_±	0.19	0.21	0.14	1.13	1.09	0.79	0.22	0.22	0.15
CD (P=0.05)	0.55	0.61	0.40	NS	NS	2.21	0.63	0.61	0.43
Vermicompost level									
vermicomposting 0kg/tree (V ₀)	13.17	13.20	13.18	93.03	89.27	91.15	6.97	10.77	8.87
vermicomposting 4.0kg/tree (V ₁)	13.95	13.98	13.96	92.68	89.90	91.29	7.32	10.10	8.71
In-situ vermicomposting (V ₂)	13.75	13.78	13.77	92.70	90.09	91.39	7.30	9.91	8.61
SEm_±	0.17	0.18	0.12	0.98	0.94	0.68	0.19	0.19	0.13
CD (P=0.05)	0.47	0.52	0.35	NS	NS	NS	NS	0.53	NS
<i>Azotobacter</i> level									
<i>Azotobacter</i> 0g/tree (A ₀)	13.61	13.64	13.63	92.85	89.51	91.18	7.15	10.49	8.82
<i>Azotobacter</i> 200g/tree (A ₁)	13.63	13.66	13.65	92.76	90.00	91.38	7.24	10.03	8.64
SEm_±	0.14	0.15	0.10	0.80	0.77	0.56	0.16	0.15	0.11
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	0.43	NS

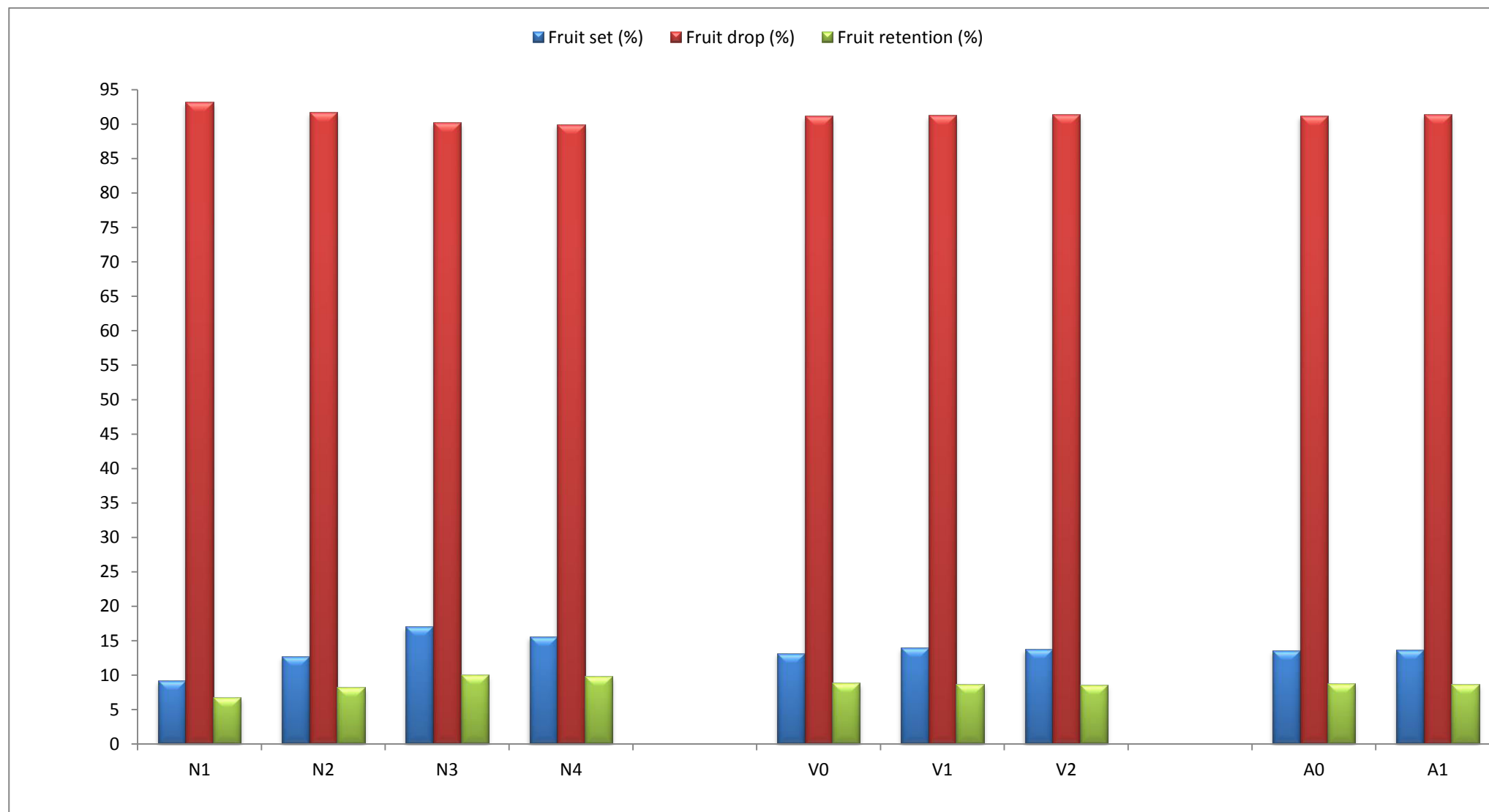


Fig.4.2: Effect of nitrogen, vermicompost and *Azotobacter* application on fruit set, drop and retention of mango cv. Amrapali under HDP

4.1.3. Effect of nitrogen, vermicompost and *Azotobacter* on physical parameters of fruit and fruit yield

The observations recorded on fruit weight, fruit length, fruit width, fruit volume and specific gravity of fruit as affected by different treatments have been given in Table 4.3a and Fig 4.3. It is apparent from the data that the largest fruit weight 190.61 g was noted with the application of nitrogen @ 120 g / tree (N_4), which was found outstanding being significant superior to all the levels of nitrogen. The lowest fruit weight (146.55 g) was noticed with nitrogen level of N_3 i.e. @ 100 g. nitrogen/ tree.

The analysed pooled data indicated that the main effect of *Azotobacter* gave significant role in fruit weight. Highest fruit weight 169.08 g was noted with the application of *Azotobacter* @ 200 g/plant (A_1).

During both the years, the highest fruit length (10.94 cm and 9.77 cm) was noted with the application of nitrogen @ 120 g /tree (N_4), which was found significantly superior to all the other rest levels of nitrogen. The lowest fruit length (10.17 cm and 9.01 cm) was showed with the application of nitrogen @ 100 g/tree (N_3). Similarly the pooled data revealed that the maximum fruit set (10.35 cm) was noted with the application of nitrogen @ 120g/tree.

The fruit width significantly increased with the increasing level of nitrogen from 60 to 120 g/tree. On the basis of pooled data, 6.65 cm fruit width was noted with the application nitrogen @ 120 g / tree (N_4) which was significantly superior to rest of the levels of nitrogen (i.e.60, 80 and 100 g/tree).

It was noticed that the application of vermicompost brought significant variation with respect to fruit weight. The plant getting *in-situ* vermicompost produced significantly higher fruit weight (169.29 g/fruit) which was noted as statistically equal without application of vermicompost (V_0). Lowest fruit weight (163.26 g/fruit) was recorded in plant grown with vermicomposting @ 4.0 kg/tree (V_1).

The data accumulated on account of fruit width as influenced by the application of vermicompost was found to be significant. On the basis of pooled data, the plant getting *In-situ* vermicompost (V_2) produced significantly highest fruit width (6.50 cm), which was statistically at par with plant grown without vermicompost (V_0). However, the lowest fruit width (6.11 cm) was recorded in that plant grown with the vermicomposting @ 4.0 kg/tree (V_1).

Table 4.3 a: Effect of nitrogen, vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Fruit weight (g)			Fruit length (cm)			Fruit width (cm)			Volume (cm ³)			Specific gravity Fruit		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen level															
N ₁	164.56	156.59	160.57	10.31	9.21	9.76	5.95	6.20	6.07	161.74	154.13	157.94	1.023	1.021	1.022
N ₂	173.29	164.79	169.04	10.58	9.43	10.00	6.40	6.18	6.29	171.35	162.38	166.87	1.021	1.015	1.018
N ₃	151.37	141.73	146.55	10.17	9.01	9.59	6.72	6.06	6.39	148.56	139.90	144.23	1.020	1.020	1.020
N ₄	194.58	186.64	190.61	10.94	9.77	10.35	6.79	6.52	6.65	191.59	184.72	188.16	1.005	1.012	1.009
SEm_±	2.76	3.52	1.77	0.41	0.34	0.09	0.09	0.14	0.08	2.18	3.33	1.99	0.02	0.03	0.02
CD (P=0.05)	7.86	10.03	4.96	0.14	0.12	0.26	0.26	NS	0.23	6.22	9.49	5.60	NS	NS	NS
Vermicompost level															
V ₀	171.18	163.88	167.53	10.60	9.48	10.04	6.08	6.14	6.11	169.16	161.45	165.30	1.013	1.019	1.016
V ₁	166.71	159.81	163.26	10.43	9.28	9.86	6.60	6.29	6.44	163.90	156.38	160.14	1.017	1.014	1.016
V ₂	174.95	163.63	169.29	10.47	9.31	9.89	6.71	6.29	6.50	171.88	163.03	167.45	1.022	1.018	1.020
SEm_±	2.392	3.05	1.53	0.36	0.29	0.08	0.08	0.12	0.07	1.89	2.89	1.73	0.02	0.03	0.02
CD (P=0.05)	NS	NS	4.29	NS	NS	NS	0.22	NS	0.20	5.39	NS	4.85	NS	NS	NS
<i>Azotobacter</i> level															
A ₀	167.76	160.84	164.30	10.45	9.32	9.88	6.36	6.19	6.27	164.77	159.41	162.09	1.015	1.015	1.015
A ₁	174.14	164.03	169.08	10.55	9.39	9.97	6.57	6.29	6.43	171.85	161.16	166.51	1.020	1.019	1.019
SEm_±	1.953	2.49	1.25	0.29	0.24	0.07	0.06	0.16	0.06	1.54	2.36	1.41	0.01	0.02	0.01
CD (P=0.05)	5.56	NS	3.51	NS	NS	NS	0.18	NS	NS	4.40	NS	3.96	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

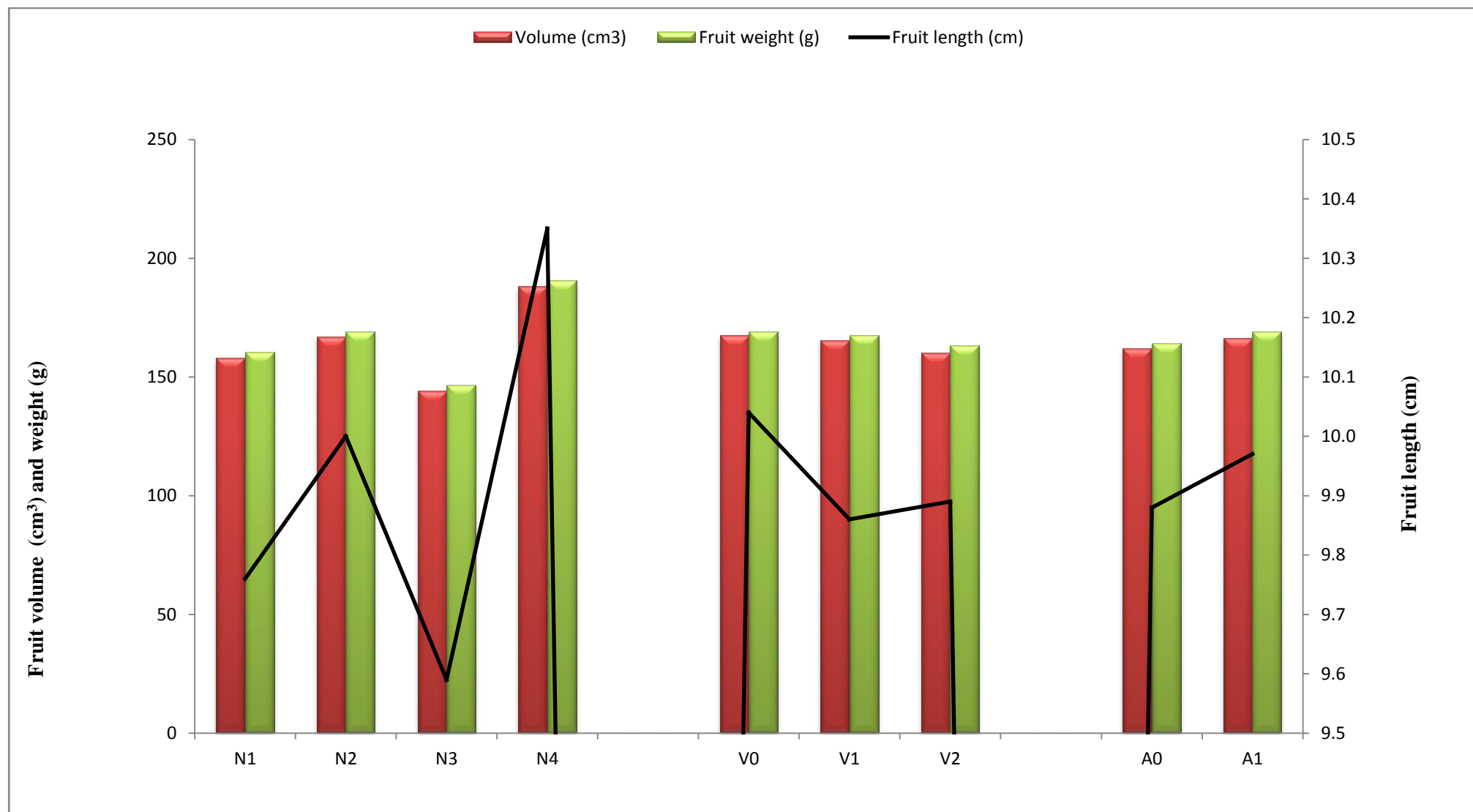


Fig.4.3: Effect of nitrogen, vermicompost and *Azotobacter* application on fruit volume, fruit weight and fruit length of mango cv. Amrapali under HDP

The application of nitrogen caused significant variation in fruit volume during both the years. According to pooled data, maximum fruit volume (188.16 cm^3) was recorded with the application of nitrogen @ 120 g/tree, which was statistically superior to rest of the levels of nitrogen. However, the lowest fruit volume (144.23 cm^3) was recorded with the application of nitrogen @ 100 g/tree.

The data accumulated on account of fruit volume as influenced by the application of vermicompost was found to be significant. On the basis of pooled data, the plant getting *In-situ* vermicompost produced significantly highest fruit volume (167.45 cm^3), which was at par with application of without vermicomposting (V_2) giving fruit volume of 165.30 cm^3 . The lowest fruit volume (160.14 cm^3) was noted with application of vermicompost @ 4 kg/tree (V_1).

The analysed pooled data indicated that the main effect of *Azotobacter* gave significant role in fruit weight. Highest fruit weight 169.08 g was noted with the application of *Azotobacter* @ 200 g/plant (A_1).

The main effect of *Azotobacter* brought significant effect on fruit volume. The maximum fruit volume (166.51 cm^3) was found with the application of *Azotobacter* @ 200 g / tree (V_1) whereas, the minimum fruit volume (162.09 cm^3) was found in the absence of *Azotobacter* (V_0).

Pooled data indicated that the application of nitrogen, vermicompost and *Azotobacter* did not produced significant improvement towards specific gravity of fruit.

Data pertaining to pulp weight, stone weight and peel weight as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been also given in Table 4.3b and graphically illustrated in Fig. 4.4

The application of nitrogen brought the significant impact towards pulp weight of fruit during both the years. According to pooled data, the highest pulp weight (122.82 g/fruit) was recorded under nitrogen @ 120 g/tree (N_4) and proved its superiority over remaining levels of nitrogen. The lowest pulp weight (96.84 g/fruit) was noted with the application of nitrogen @ 100g/tree (N_3).

The pooled data showed the progressive response of vermicompost on pulp weight. The maximum pulp weight (108.17 g) was found with the application *In-situ* vermicomposting, which was statistically at par with in the absence of vermicomposting. The minimum pulp weight (104.11 g/fruit) was noted with the application of vermicompost @ 4.0 kg/tree.

The analysed pooled data indicated that the main effect of *Azotobacter* brought significant improvement in pulp weight and recorded the highest value of pulp weight 108.66 g/fruit with the application of *Azotobacter* @ 200 g/plant (A₁).

An examination of data revealed that the application of nitrogen @ 100 g /tree (N₃) recorded the lowest stone weight (21.39 g/fruit and 21.84 g/fruit) during both the years, respectively, which was found outstanding being significantly superior to all other levels of nitrogen. The highest stone weight (30.57 and 31.42 g/fruit) was showed with the application nitrogen @ 120 g/tree (N₄). Pooled data also showed the similar trends.

The perusal of analysed pooled data in respect of stone weight revealed that the main effect of vermicompost caused significant variation. The minimum stone weight (26.25 g/fruit) was recorded with the application of vermicompost @ 4.0 kg/tree which was noted as statistically equal with *In-situ* vermicomposting and without vermicomposting that gave the value of stone weight 26.59 g/fruit and 27.21 g / fruit, respectively.

The data accumulated on account of stone weight influenced significantly by the use of *Azotobacter*. The Plants without *Azotobacter* produced 26.51 g / fruit which were significantly lesser than the *Azotobacter* @ 200 g/tree.

Table 4.3 b: Effect of nitrogen, vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp weight (g/fruit)			Stone weight (g)			Peel weight (g)		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	97.46	100.72	99.09	26.78	27.54	27.16	27.25	28.33	27.79
Nitrogen @80g/tree (N ₂)	107.19	109.80	108.50	26.63	27.31	26.97	26.86	27.67	27.27
Nitrogen @100g/tree (N ₃)	95.76	97.91	96.84	21.39	21.84	21.62	21.71	22.57	22.14
Nitrogen @120g/tree (N ₄)	121.12	124.53	122.82	30.57	31.42	30.99	30.47	31.26	30.86
SEm _±	2.30	1.90	1.49	0.68	0.56	0.44	1.12	0.20	0.57
CD (P=0.05)	6.56	5.42	4.20	1.94	1.58	1.24	3.19	0.58	1.60
Vermicompost level									
vermicomposting 0kg/tree (V ₀)	106.02	110.28	108.15	25.82	27.01	26.59	25.81	27.00	26.53
vermicomposting 4.0kg/tree (V ₁)	102.60	105.61	104.11	26.18	26.69	26.25	26.05	26.68	26.24
In-situ vermicomposting (V ₂)	107.52	108.83	108.17	27.03	27.38	27.21	27.86	28.70	28.28
SEm _±	2.00	1.65	1.29	0.59	0.48	0.38	0.97	0.18	0.49
CD (P=0.05)	NS	NS	3.63	NS	NS	1.07	NS	0.50	1.38
<i>Azotobacter</i> level									
<i>Azotobacter</i> 0g/tree (A ₀)	102.90	107.02	104.96	25.95	27.08	26.51	26.36	27.59	26.98
<i>Azotobacter</i> 200g/tree (A ₁)	107.86	109.46	108.66	26.73	26.98	26.85	26.79	27.33	27.06
SEm _±	1.63	1.35	1.06	0.48	0.39	0.31	0.97	0.14	0.40
CD (P=0.05)	4.64	NS	2.97	NS	NS	0.87	NS	NS	NS

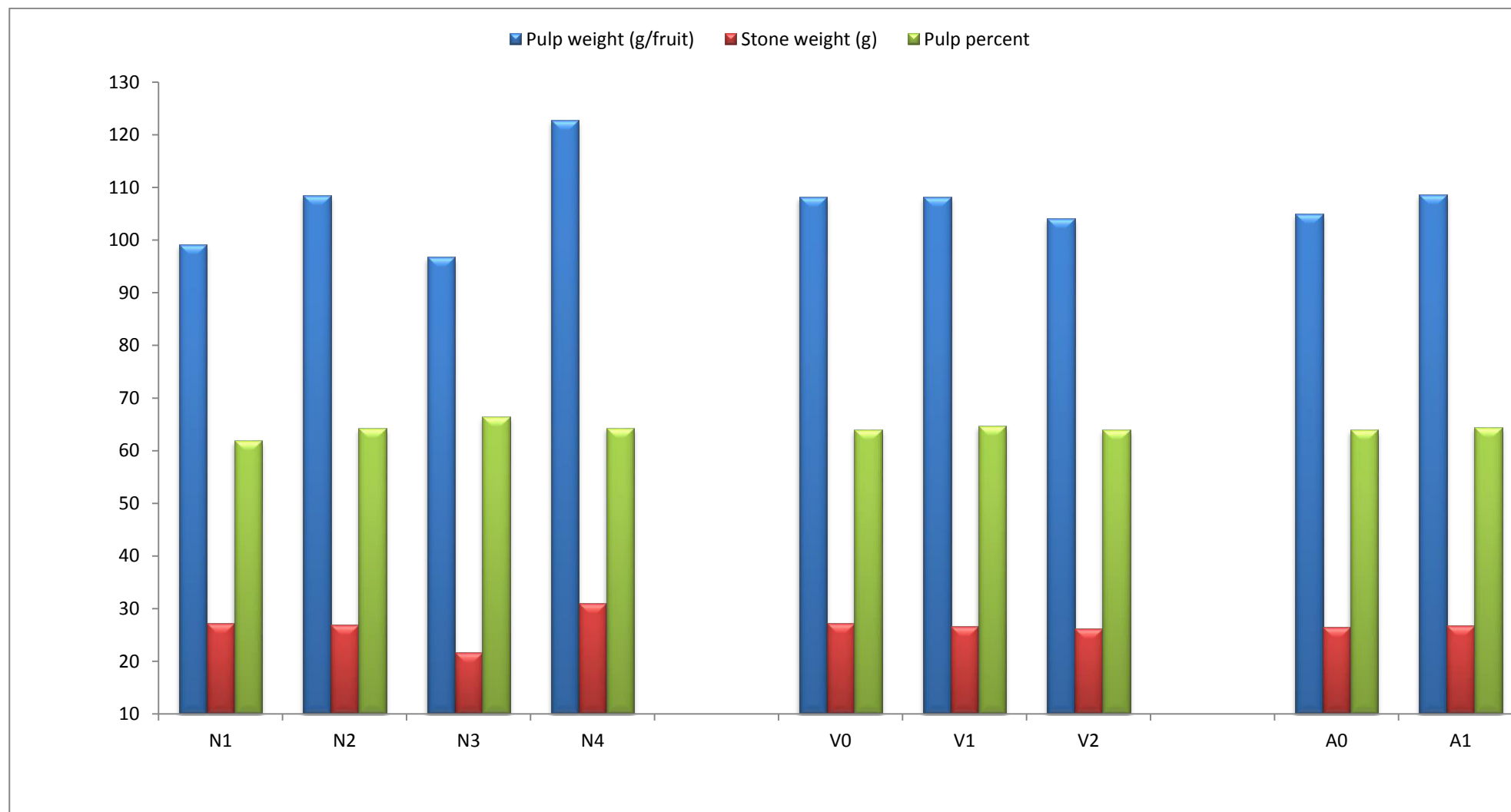


Fig.4.4: Effect of nitrogen, vermicompost and *Azotobacter* application on pulp weight, stone weight and pulp percent of mango cv. Amrapali under HDP

A scrutiny of data displayed in mean summary table indicates that the different levels of nitrogen brought significant variation in respect of peel weight. On the basis of pooled data, the plant getting nitrogen @ 100 g/tree produced lowest peel weight (22.14 g / fruit), which was noted as significantly superior to rest of the levels of nitrogen, whereas, the highest peel weight (30.86 g / fruit) was noticed with the application of nitrogen @ 120 g/tree.

The analysed pooled data indicated that the main effect of vermicompost showed significant variation regarding to peel weight. The plant getting vermicompost @ 4.0 kg/tree produced significantly lowest peel weight (26.24 g/fruit).

Different levels of nitrogen showed the significant variation regarding to pulp percent. Plant getting nitrogen @ 100 g/tree (N_3) produced highest pulp percent (66.44%), which was statistically similar with application of nitrogen @ 120g (N_4) and 80g/tree (N_2) that produced 64.34 and 64.29 % respectively, whereas the minimum pulp percent (61.90 %) was noted with the application of nitrogen @ 60g/tree (N_1).

Data pertaining to pulp percent, pulp: stone ratio and pulp: peel ratio as influenced by various levels of nitrogen, Vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been also given in Table 4.3c -and graphically illustrated in Fig. 4.4.

Table 4.3 c: Effect of nitrogen, vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp percent			Pulp stone ratio			Pulp peel ratio		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen level									
Nitrogen @60g/tree (N ₁)	59.52	64.28	61.90	3.66	3.66	3.66	3.60	3.57	3.59
Nitrogen @80g/tree (N ₂)	61.89	66.69	64.29	4.04	4.04	4.04	4.01	3.98	4.00
Nitrogen @100g/tree (N ₃)	63.26	69.61	66.44	4.48	4.50	4.49	4.42	4.35	4.38
Nitrogen @120g/tree (N ₄)	62.25	66.44	64.34	3.97	3.95	3.96	3.98	3.97	3.97
SEm_±	0.98	1.31	0.82	0.10	0.09	0.07	0.11	0.07	0.06
CD (P=0.05)	NS	NS	2.30	0.28	0.27	0.19	0.31	0.20	0.18
Vermicompost level									
vermicomposting 0kg/tree (V ₀)	61.46	66.58	64.02	4.00	3.99	3.99	3.89	3.82	3.86
vermicomposting 4.0kg/tree (V ₁)	62.21	67.18	64.70	4.11	4.13	4.12	4.11	4.10	4.11
In-situ vermicomposting (V ₂)	61.52	66.51	64.01	4.01	3.99	4.00	4.00	3.98	3.99
SEm_±	0.85	1.13	0.71	0.09	0.08	0.06	0.09	0.06	0.06
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	0.17	0.16
<i>Azotobacter</i> level									
<i>Azotobacter</i> 0g/tree (A ₀)	61.35	66.63	63.99	4.00	3.98	3.99	3.94	3.91	3.92
<i>Azotobacter</i> 200g/tree (A ₁)	62.11	66.88	64.49	4.08	4.09	4.09	4.07	4.03	4.05
SEm_±	0.69	0.93	0.58	0.07	0.07	0.05	0.08	0.05	0.05
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.13

An examination of data revealed that the highest pulp: stone ratio (4.48 and 4.50) was noted with the application of nitrogen @ 100 g /tree (N_3) during both of the years, which was found outstanding being significantly superior to all other levels of nitrogen. The lowest pulp: stone ratio (3.66) was showed with the application nitrogen @ 60 g/tree (N_1). A similar trend was also noted after pooled over two years.

The perusal of analysed pooled data in respect of pulp: stone ratio revealed that the application of vermicompost and *Azotobacter* did not touch the level of significance.

An examination data revealed that the use of different levels nitrogen caused significant variation in pulp: peel ratio. The utmost value of pulp: peel ratio (4.38) was recorded with the application nitrogen @ 100g/tree, which was significantly superior to remaining levels of nitrogen. Whereas, the minimum pulp: peel ratio (3.59) was noted with plant grown under 60g nitrogen per tree.

The pulp: peel ratio was also influenced by different levels of vermicompost. The application of vermicompost @ 4.0 kg/tree produced significantly maximum pulp: peel ratio (4.11), which was at par with *In-situ* vermicomposting (3.99). The minimum pulp: peel ratio (3.86) was recorded under the treatment without f vermicomposting.

A perusal data indicates that the use of *Azotobacter* caused significant variation in pulp: peel ratio. Application of 200g of *Azotobacter* per tree gave significantly highest value of pulp: peel ratio (4.05), while the lowest pulp: peel ratio (3.92) was found under the treatment without *Azotobacter*.

Data pertaining to number of fruits/tree, yield (kg/tree) and yield (t/ha as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been also given in Table 4.3d and graphically illustrated in Fig. 4.5.

The application of nitrogen brought significant impact towards number of fruits / tree during both the years. According to pooled data, the highest number of fruit/tree (76.32 fruits / tree) was recorded with application of nitrogen @ 100 g/tree (N_3) and proved its superiority over remaining levels of nitrogen. The lowest number of fruits / tree (46.90) was noted with the application of nitrogen @ 60g/tree (N_1).

An examination of pooled data showed that the vermicomposting showed significant variation on number of fruits per tree. The highest number of fruits per plant (60.81) was noted with vermicomposting @ 4.0 kg/tree (V_1), which was statically at par with *In-situ* vermicomposting (60.51). The lowest number of fruits per plant (53.60) was noted under the treatment without application of vermicompost (V_0).

Table 4.3d: Effect of nitrogen, vermicompost and *Azotobacter* on fruits /tree and yield of mango cv. Amrapali under HDP

Treatment	Number of fruits /tree			Yield (kg/tree)			Yield (t/ha)		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	41.47	52.33	46.90	6.88	7.85	7.37	10.52	15.33	12.92
Nitrogen @80g/tree (N ₂)	47.04	60.33	53.69	7.99	9.85	8.92	12.56	17.45	15.01
Nitrogen @100g/tree (N ₃)	68.53	84.11	76.32	10.86	11.73	11.29	16.38	21.11	18.75
Nitrogen @120g/tree (N ₄)	51.49	61.17	56.33	10.01	11.41	10.71	16.06	20.64	18.35
SEm_±	2.70	0.53	1.37	0.26	0.12	0.15	0.37	0.32	0.25
CD (P=0.05)	7.68	1.51	3.86	0.75	0.34	0.41	1.07	0.91	0.69
Vermicompost level									
vermicomposting 0kg/tree (V ₀)	46.33	60.88	53.60	8.47	9.23	9.87	13.06	17.91	15.49
vermicomposting 4.0kg/tree (V ₁)	54.75	66.88	60.81	9.22	10.56	9.89	14.29	19.10	16.69
In-situ vermicomposting (V ₂)	55.31	65.71	60.51	9.11	10.20	9.65	14.29	18.89	16.59
SEm_±	2.34	0.46	1.19	0.23	0.10	0.13	0.32	0.28	0.21
CD (P=0.05)	6.65	1.31	3.34	0.65	0.30	0.35	0.92	0.98	0.60
Effect of									
<i>Azotobacter</i> 0g/tree (A ₀)	51.34	63.61	57.48	8.79	10.04	9.42	13.77	18.49	16.13
<i>Azotobacter</i> 200g/tree (A ₁)	52.92	65.36	59.14	9.08	10.37	9.73	13.99	18.77	16.38
SEm_±	1.91	0.38	0.97	0.19	0.09	0.10	0.26	0.22	0.17
CD (P=0.05)	NS	1.07	NS	NS	0.24	0.29	NS	NS	NS

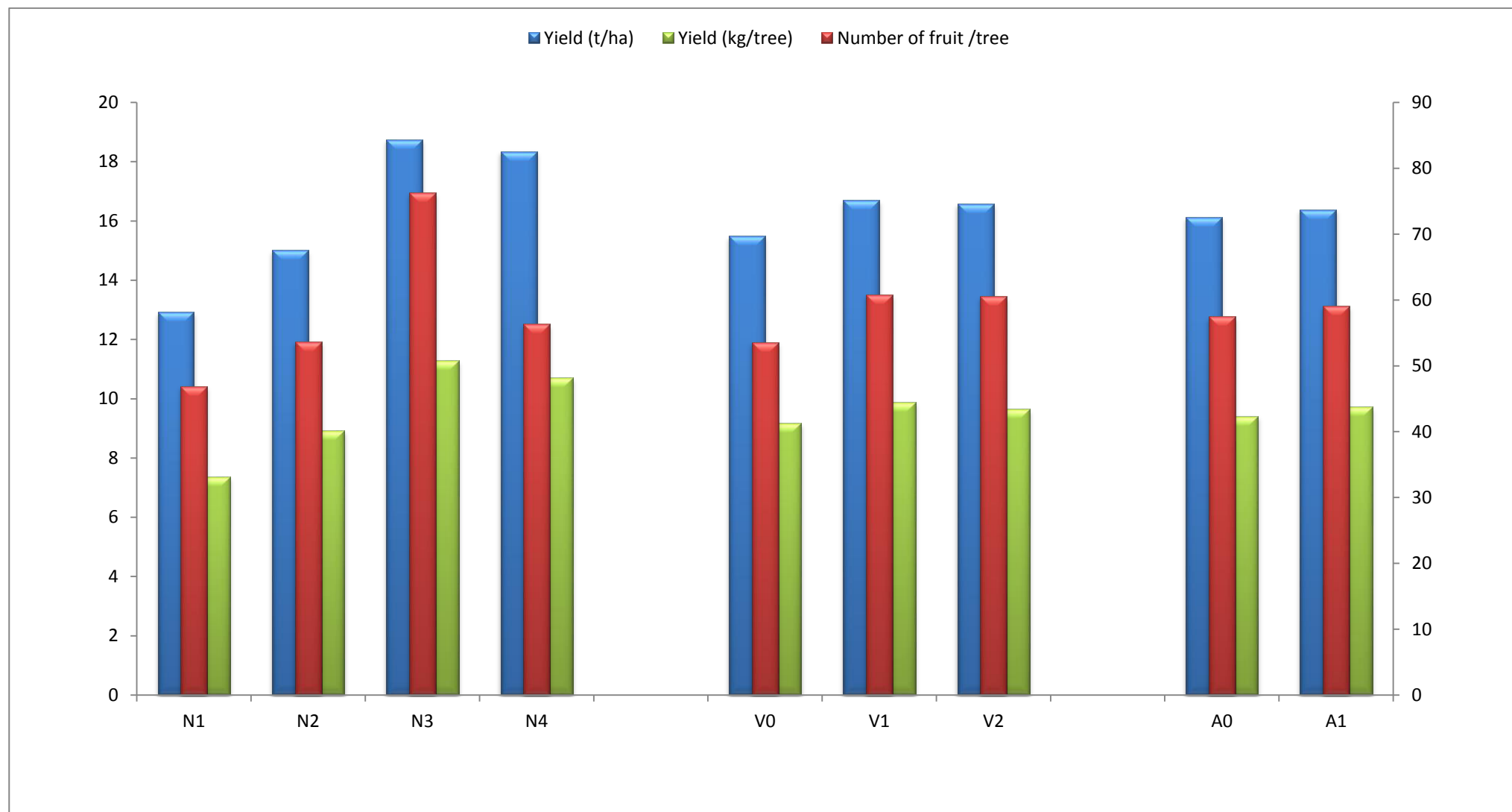


Fig.4.5: Effect of nitrogen, vermicompost and *Azotobacter* application on fruits/tree and fruit yield of mango cv. Amrapali under HDP

An examination data revealed that the different levels of levels nitrogen caused significant variation in fruit yield (kg / tree). The utmost value of fruit yield (11.29 kg / tree) was recorded with the application nitrogen @ 100g/tree (N_3), which was significantly superior to remaining levels nitrogen. Whereas, the minimum fruit yield (7.37 kg / tree) was noted with the application of 60g/tree nitrogen tree (N_1).

The analysed pooled data indicated that the main effect of vermicompost showed significant effects on yield (kg/tree). The application of vermicompost @ 4.0 kg/tree produced significantly maximum fruit yield (9.89 kg/tree) which was at par with *In-situ* vermicomposting that gave fruit yield of 9.65 kg/tree. The minimum fruit yield (9.17 kg/tree) was recorded under the treatment without vermicomposting.

A perusal of pool data indicates that the main effect of *Azotobacter* caused significant variation in fruit yield (kg/tree). Application of 200g of *Azotobacter* per tree was produced significantly highest fruit yield (9.73 kg / tree), while the lowest yield (9.42 kg / tree) was found under the treatment without *Azotobacter*.

An examination of data revealed that the highest fruit yield (16.38 and 21.11 t /ha) was noted with the application of nitrogen @ 100 g/tree (N_3) during both the years, respectively, which was found outstanding being significant superior to all other levels of nitrogen. The lowest yield (10.52 and 15.33 t /ha) was showed with the application nitrogen @ 60 g/tree (N_1). Pooled data also showed the similar trends.

A perusal of data indicates that the vermicomposting produced significant effect on fruit yield during both of the year. The maximum fruit yield (16.69 t/ha) was noted with the application of vermicompost @ 4.0 kg / tree (V_1). The lowest fruit yield (15.49 t/ha) was observed under the treatment without vermicomposting (V_0).

However the *Azotobacter* application did not cause any significant variation in yield (t/ha) during both the years as well as pooled over two years.

4.1.4. Effect of nitrogen, vermicompost and *Azotobacter* on biochemical and antioxidant compounds

Data pertaining to TSS, titratable acidity, TSS: acidity ratio, total sugar, total carotenoids and ascorbic acid content as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been also given in Table 4.4a and 4.4b and graphically illustrated in Fig. 4.6a and 4.6b.

It was noticed that the application of different levels of nitrogen brought significant variation with respect to TSS. The maximum fruit TSS (23.30 °Brix) was noted with the

application of nitrogen @ 100 g/tree (N_3), which was found outstanding being significant superior to all other levels of nitrogen. The lowest fruit TSS (20.82 °Brix) was noticed with N_1 i.e. application of nitrogen @ 60g/tree.

The analysed pooled data indicates that the various levels of vermicompost brought significant improvements towards TSS of fruit. The maximum TSS (21.99 °Brix) was noted with the application of *In-situ* vermicompost (V^2), which was statistically at par with (V_1) vermicomposting @ 4.0 kg / tree (21.98 °Brix). The lowest TSS (21.59 °Brix) was observed under the treatment without vermicomposting (V_0).

The application of different levels of nitrogen showed the significant variation towards fruit acidity. The lowest fruit acidity (0.164%) was noted with application of nitrogen @ 100 g/tree (N_3), which showed superiority over remaining levels of nitrogen. The highest fruit acidity (0.243%) was noted with the application of nitrogen @ 60 g/tree (N_1).

Acidity of fruit also influenced significantly with the application of various levels of vermicompost. The lowest acidity (0.172) was noted with vermicomposting @ 4 kg / tree (V_1). The highest fruit acidity (0.249%) was noted under the treatment without vermicomposting (V_0).

Table 4.4a: Effect of nitrogen, vermicompost and *Azotobacter* on bio-chemical and anti oxidant compounds in mango fruit cv. Amrapali under HDP

Treatment	TSS (⁰ B)			Titratable acidity (%)			TSS/Acidity		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	20.81	20.82	20.82	0.245	0.240	0.243	87.22	88.02	87.62
Nitrogen @80g/tree (N ₂)	21.85	21.89	21.87	0.213	0.196	0.204	107.18	116.06	111.62
Nitrogen @100g/tree (N ₃)	23.27	23.33	23.30	0.168	0.161	0.164	143.60	151.28	147.44
Nitrogen @120g/tree (N ₄)	21.41	21.45	21.43	0.198	0.191	0.195	110.90	115.40	113.15
SEm_±	0.18	0.17	0.12	0.002	0.001	0.001	1.19	0.62	0.67
CD (P=0.05)	0.51	0.49	0.35	0.006	0.004	0.003	3.39	1.77	1.88
Vermicompost level									
vermicomposting 0kg/tree (V ₀)	21.57	21.61	21.59	0.256	0.242	0.249	86.71	91.89	89.30
vermicomposting 4.0kg/tree (V ₁)	21.96	21.99	21.98	0.174	0.170	0.172	130.05	134.57	132.31
In-situ vermicomposting (V ₂)	21.97	22.01	21.99	0.188	0.179	0.184	119.91	126.61	123.26
SEm_±	0.15	0.15	0.10	0.002	0.001	0.001	1.03	0.54	0.58
CD (P=0.05)	NS	NS	0.30	0.005	0.003	0.002	2.93	1.53	1.63
<i>Azotobacter</i> level									
<i>Azotobacter</i> 0g/tree (A ₀)	21.77	21.81	21.79	0.213	0.205	0.209	108.52	113.40	110.96
<i>Azotobacter</i> 200g/tree (A ₁)	21.90	21.93	21.92	0.199	0.189	0.194	115.93	121.98	118.96
SEm_±	0.13	0.12	0.09	0.001	0.001	0.001	0.84	0.44	0.47
CD (P=0.05)	NS	NS	NS	0.004	0.003	0.002	2.39	1.25	1.33

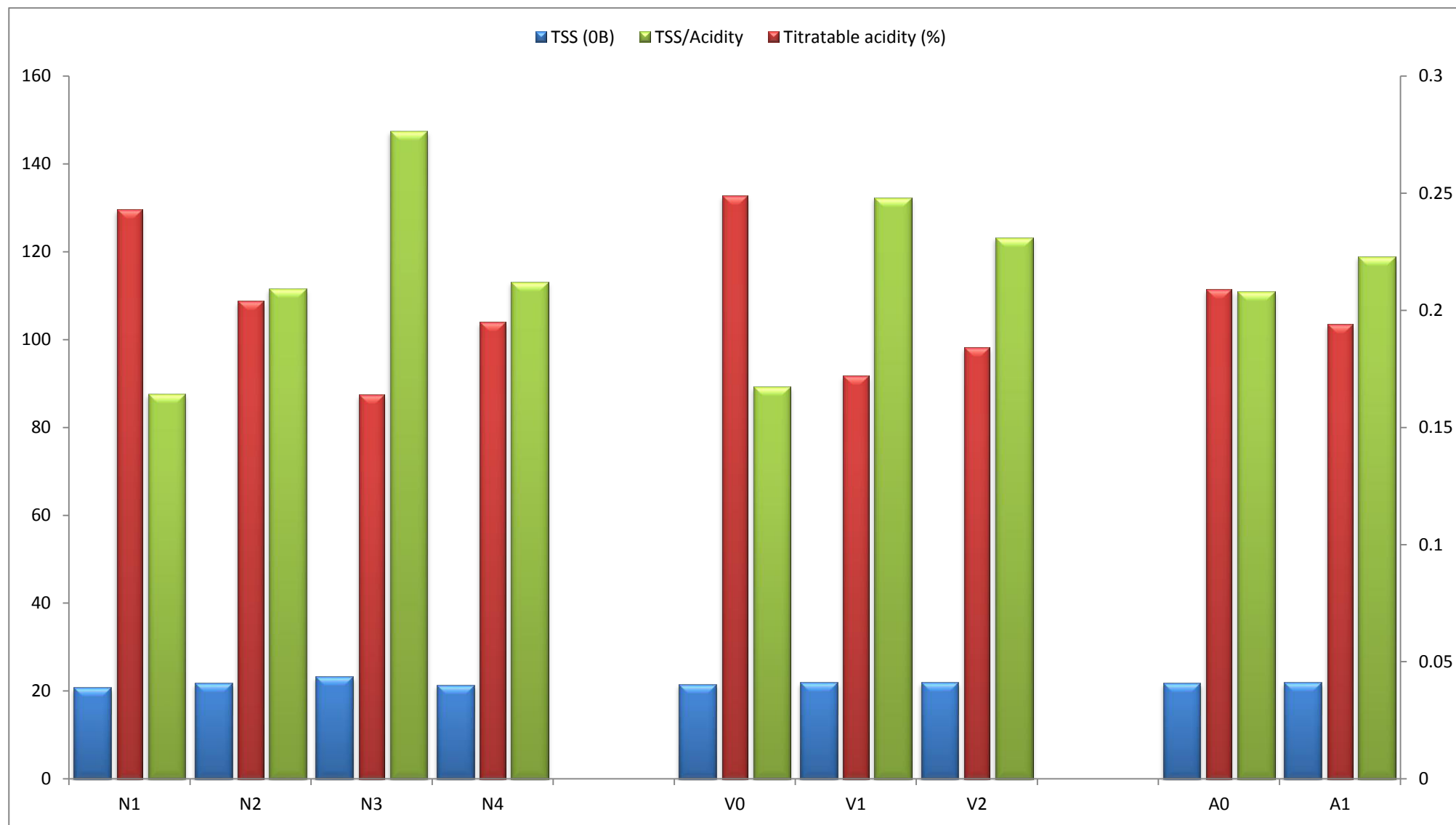


Fig.4.6 a: Effect of nitrogen, vermicompost and *Azotobacter* application on bio-chemical compounds in mango cv. Amrapali under HDP

Azotobacter caused the significant effect on acidity of fruit. The minimum acidity (0.194%) was found with the application of *Azotobacter* @ 200 g/tree (A_1) whereas; the maximum fruits acidity (0.209%) was noted in the absence of *Azotobacter* (A_0).

Pooled analysed of data revealed that the application of different dose of nitrogen showed significant variation in TSS/acidity ratio. The highest TSS/acidity ratio (147.44) was noted with the application of nitrogen @ 100 g/tree (N_3). The lowest TSS/acidity ratio (87.62) was found with the application of 60 g of nitrogen per tree (N_1).

The main effect of levels of vermicompost also expressed significant variation in respect of TSS/acidity ratio. The highest TSS/acidity ratio (132.31) was noted with the application of vermicompost @ 4.0 kg/tree (V_1).whereas, the lowest TSS/acidity ratio (89.30) was noted without application of vermicompost (V_0).

A perusal of data in respect of TSS/acidity ratio of fruit varied significantly due to the use of *Azotobacter*. The maximum TSS/acidity ratio (118.96) was noted with the application of *Azotobacter* @ 200 g/tree (A_1), whereas, minimum value (110.96) was noted under the treatment without *Azotobacter* (A_0).

Table 4.4b: Effect of nitrogen, vermicompost and *Azotobacter* on bio-chemical parameters in mango fruit cv. Amrapali under HDP

Treatment	Total sugars (%)			Total carotenoids (mg/100g pulp)			Ascorbic acid content (mg/100 g pulp)		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	15.79	15.79	15.79	16.14	17.04	16.59	29.68	31.84	30.76
Nitrogen @80g/tree (N ₂)	17.00	17.17	17.09	17.20	17.79	17.49	34.08	34.19	34.14
Nitrogen @100g/tree (N ₃)	18.04	18.09	18.07	18.47	18.44	18.46	38.32	38.62	38.47
Nitrogen @120g/tree (N ₄)	17.42	17.49	17.46	17.63	17.62	17.62	37.04	37.13	37.08
SEm_±	0.11	0.09	0.07	0.12	0.01	0.07	0.30	0.27	0.20
CD (P=0.05)	0.31	0.25	0.19	0.34	0.21	0.20	0.86	0.76	0.56
Vermicompost level									
vermicomposting 0kg/tree (V ₀)	16.86	16.89	16.87	17.09	17.56	17.33	33.83	34.58	34.21
vermicomposting 4.0kg/tree (V ₁)	17.18	17.23	17.20	17.48	17.80	17.64	35.04	35.82	35.43
In-situ vermicomposting (V ₂)	17.15	17.29	17.22	17.50	17.80	17.65	35.47	35.94	35.7
SEm_±	0.09	0.07	0.06	0.1	0.06	0.06	0.26	0.23	0.17
CD (P=0.05)	0.27	0.21	0.17	0.3	0.18	0.17	0.74	0.66	0.49
<i>Azotobacter</i> level									
<i>Azotobacter</i> 0g/tree (A ₀)	17.02	17.06	17.04	17.29	17.68	17.49	34.52	35.25	34.89
<i>Azotobacter</i> 200g/tree (A ₁)	17.11	17.21	17.16	17.43	17.76	17.59	35.03	35.64	35.34
SEm_±	0.08	0.06	0.05	0.09	0.05	0.05	0.21	0.19	0.14
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.40

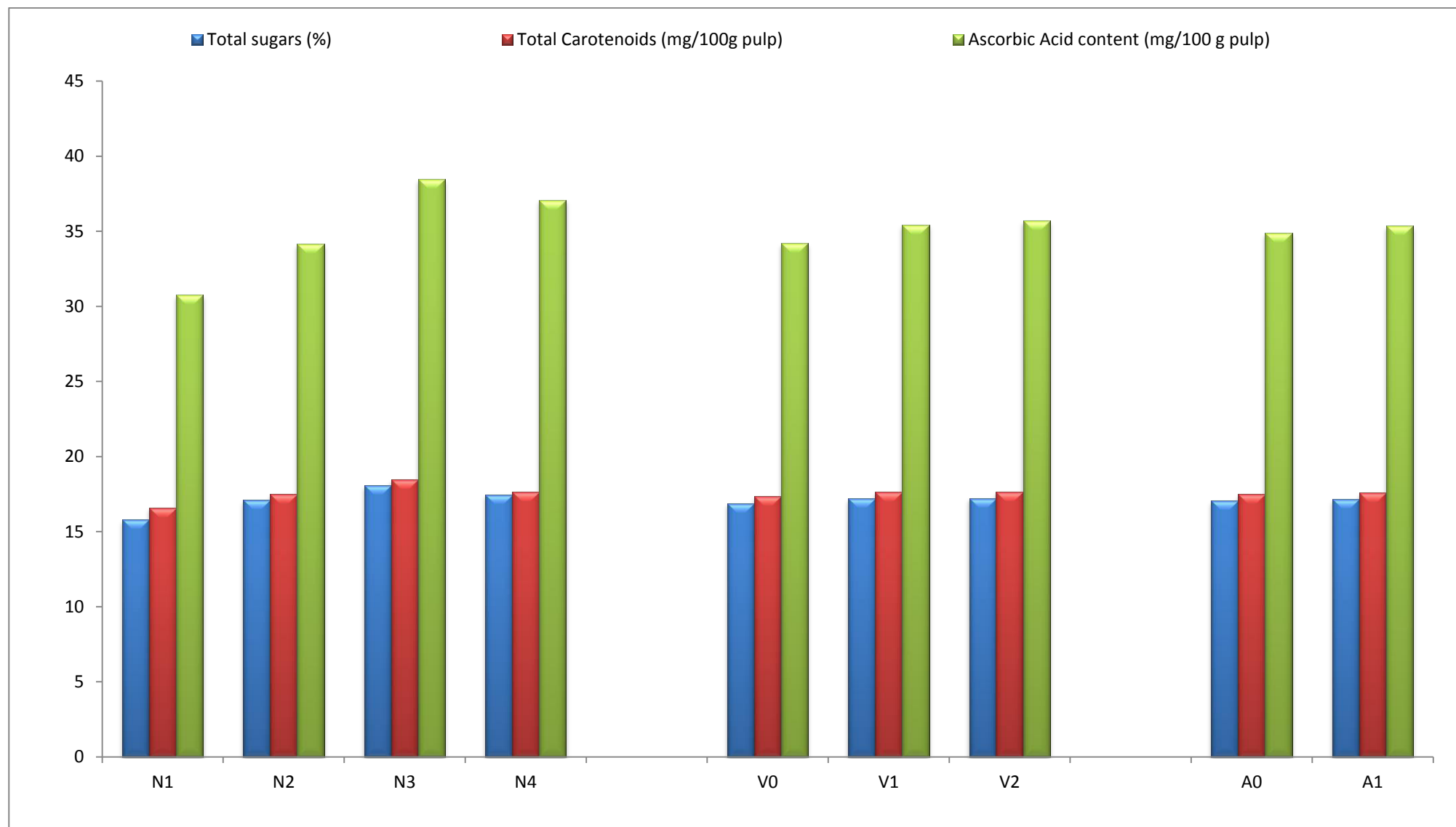


Fig.4.6 b: Effect of nitrogen, vermicompost and *Azotobacter* application on bio-chemical parameters in mango cv. Amrapali under HDP

An examination of data presented in table revealed that the total sugar content in fruits varied significantly due to varying nitrogen levels during both of the years. The highest total sugars (18.04% and 18.09%) was noted with the application of nitrogen @ 100 g/tree (N_3), which was found outstanding being significant superior to all the levels of nitrogen. The lowest total sugars content (15.79%) was showed with the application of nitrogen @ 60 g/tree (N_1). Poole data also showed the similar trends.

Different levels of vermicompost also brought significant variation with respect to total sugar content in fruits. The application of *In-situ* vermicomposting (V_2) produced significantly maximum total sugar (17.22 %) in fruits, which was statistically similar with application of vermicompost @ 4.0 kg/tree (V_1) that gave total sugars of 17.20 per cent and significantly higher than the treatment without vermicomposting (V_0).

The data accumulated on account of total carotenoid in fruits as influenced by different levels of nitrogen was found to be significant. The maximum total carotenoid (18.46 mg/100g) was noted with the application nitrogen @ 100 g/tree (N_3) which was found outstanding being significant superior to all other levels of nitrogen, whereas; the minimum total carotenoids (16.59 mg/100g) was noticed with N_1 i.e. application of nitrogen @ 60g/tree.

The application of vermicompost also caused significant variation regarding total carotenoids of fruit. The maximum total carotenoids (17.65 mg/100g) was noted with the application of *In-situ* vermicomposting (V_2), which was statically at par with (V_1) vermicomposting @ 4.0 kg/tree that gave (16.64 mg/100g).

It is evident of from the variance table that the ascorbic acid of fruit influenced significantly by different levels of nitrogen. The plant getting 100g of nitrogen per tree (N_3) produced significantly highest ascorbic acid content of fruit (38.47 mg/100g pulp), which was most superior over all the levels of nitrogen, whereas, the lowest ascorbic acid of fruit (30.76 mg/100g pulp) was recorded with the application of nitrogen @ 60 g/tree (N_1).

It is obvious from the table that the application of vermicompost @ 4.0 kg/tree (V_1) gave maximum ascorbic acid content (35.70mg/100g pulp), which was found statistically similar to *In-situ* vermicomposting (35.43 mg/100g pulp), whereas, the lowest ascorbic acid (34.21 mg/100g pulp) content was found under the treatment without vermicomposting (V_0).

Application of *Azotobacter* caused significant variation in ascorbic acid content of fruit and recorded maximum ascorbic acid (35.34 mg/100g pulp) content when *Azotobacter* was applied @ 200 g/tree (A_1), whereas, minimum ascorbic acid content of fruit (34.89 mg/100g pulp) was recorded under the treatment without *Azotobacter* (A_0).

4.1.5. Effect of nitrogen, vermicompost and *Azotobacter* on total nitrogen, phosphorus and potassium content in leaves

Data concerning to total nitrogen, phosphorus and potassium content in leaves as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been also given in Table 4.5 and graphically illustrated in Fig. 4.7

An examination of data revealed that the highest total nitrogen content (1.49 % and 1.51 %) in leaves was noted with the application of nitrogen @ 120 g/tree (N_4), which showed superiority over remaining levels of nitrogen. The lowest total nitrogen content (1.35 % and 1.26 %) was showed with the application nitrogen @ 60 g/tree (N_1) during both the years. Pooled data also showed the similar trends.

The application of vermicompost brought significant impact towards nitrogen content in leaf at fruit harvest stage during both the years. According to pooled data, the highest nitrogen content (1.42%) in leaf was recorded under *In-situ* vermicomposting (V_2), which was significantly superior over vermicompost @ 4.0 kg/tree (V_1) and without vermicomposting (V_0).

A perusal of pooled data indicated that the application of *Azotobacter* caused the significant variation on total nitrogen content in leaves. The maximum total nitrogen (1.40 %) content in leaves was found with the application of *Azotobacter* @ 200 g/tree (A_1) whereas; the minimum value (1.37%) in leaves was found in the absence of *Azotobacter* (A_0).

Table 4.5: Effect of nitrogen, vermicompost and *Azotobacter* on NPK content in mango leaf at harvest stage cv. Amrapali under HDP

Treatment	Nitrogen content in leaf (%)			Phosphorus content in leaf (%)			Potassium content in leaf (%)		
Effect of Nitrogen	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	1.35	1.26	1.30	0.09	0.10	0.09	0.89	0.91	0.90
Nitrogen @80g/tree (N ₂)	1.28	1.32	1.30	0.10	0.10	0.10	0.94	0.99	0.96
Nitrogen @100g/tree (N ₃)	1.42	1.44	1.43	0.11	0.12	0.11	1.06	1.11	1.08
Nitrogen @120g/tree (N ₄)	1.49	1.51	1.50	0.12	0.13	0.12	1.13	1.14	1.14
SEm_±	0.001	0.012	0.007	0.001	0.001	0.001	0.01	0.01	0.01
CD (P=0.05)	0.004	0.034	0.019	0.004	0.002	0.002	0.04	0.02	0.02
Effect of Vermicompost									
vermicomposting 0kg/tree (V ₀)	1.40	1.34	1.37	0.09	0.10	0.10	0.97	1.00	0.99
vermicomposting 4.0kg/tree (V ₁)	1.35	1.37	1.36	0.11	0.11	0.11	1.01	1.04	1.02
In-situ vermicomposting (V ₂)	1.41	1.43	1.42	0.11	0.13	0.12	1.04	1.07	1.06
SEm_±	0.001	0.010	0.006	0.001	0.001	0.001	0.01	0.01	0.01
CD (P=0.05)	0.003	0.029	0.017	0.003	0.001	0.002	0.03	0.02	0.02
Effect of <i>Azotobacter</i>									
<i>Azotobacter</i> 0 g/tree (A ₀)	1.36	1.38	1.37	0.10	0.11	0.10	0.99	1.03	1.01
<i>Azotobacter</i> 200g/tree (A ₁)	1.41	1.39	1.40	0.11	0.12	0.11	1.02	1.05	1.03
SEm_±	0.001	0.008	0.005	0.001	0.001	0.001	0.01	0.005	0.01
CD (P=0.05)	0.003	NS	0.014	0.003	0.001	0.001	NS	0.01	0.01

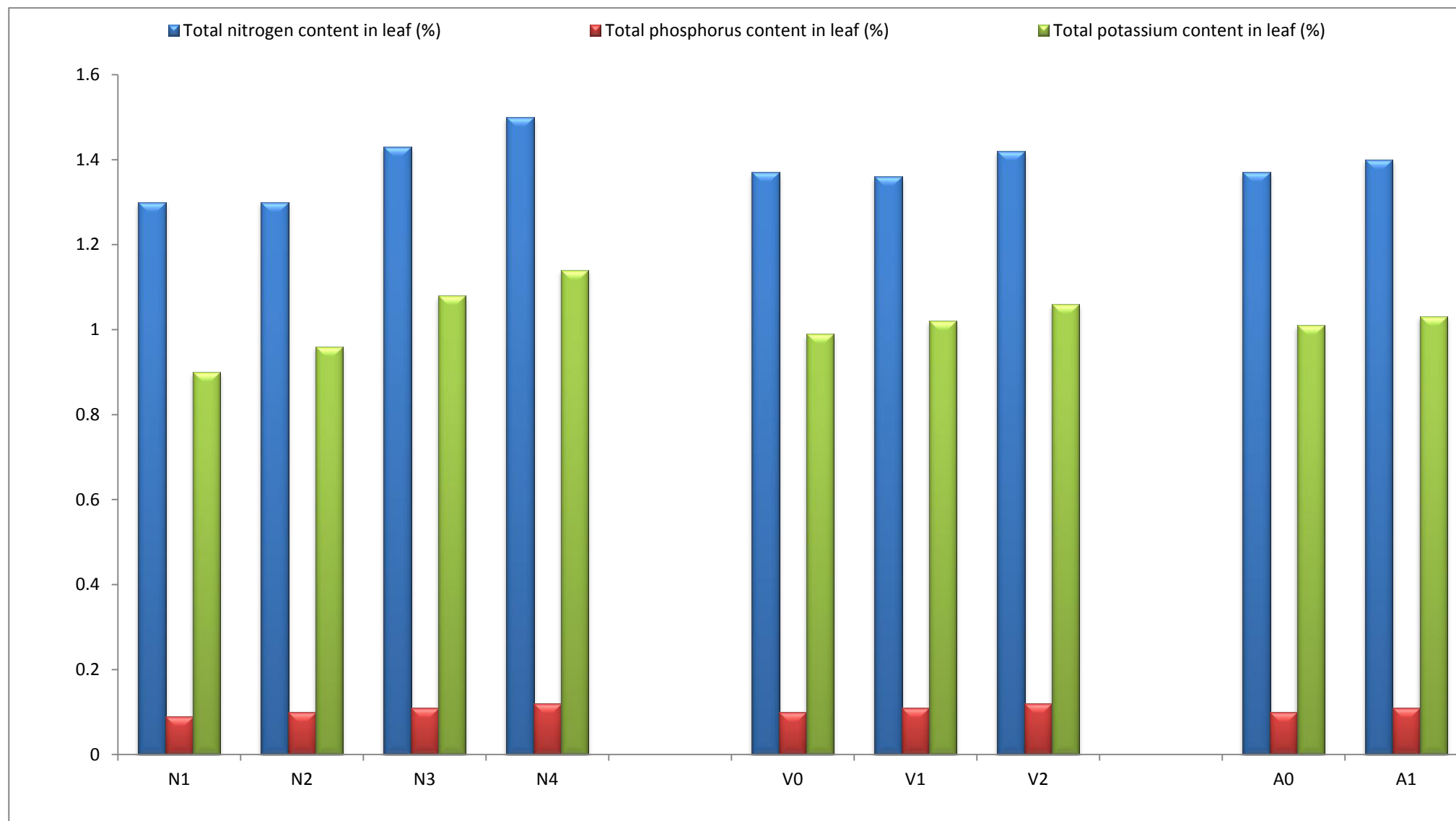


Fig.4.7:Effect of nitrogen, vermicompost and *Azotobacter* application on NPK content in mango leaf at harvest stage cv. Amrapali under HDP

Total phosphorus content in leaves at fruit harvest stage also influenced significantly due to various levels of nitrogen during both year. On the basis of pooled data, plant grown with the nitrogen @ 120 g/tree (N_4) showed significantly maximum total phosphorus content (0.12 %) in leaves which was significantly superior to all remaining levels of nitrogen. The minimum total phosphorus content (0.09 %) in leaves was found under the plant raised with the application of nitrogen @ 60 g/tree (N_1).

The data in respect of total phosphorus content in leaves at fruit harvest stage varied significantly due to vermicomposting. The plant getting *In-situ* vermicomposting produced significantly higher total phosphorus content (0.12) in leaves, which was significantly better than vermicompost @ 4.0 kg/tree (V_1) and without vermicomposting (V_0).

It is obvious from the pooled data that the application of *Azotobacter* caused significant variation in total phosphorus content in leaves at fruit harvest stage. Maximum total phosphorus content in leaves 0.11% was recorded with the application of *Azotobacter* @ 200 g / tree (A_1), which was statistically better than without application of *Azotobacter* (A_0).

Each successive levels of nitrogen showed significant impact towards potassium content in leaf during both the years. Pooled data obviously indicated that the application of nitrogen @ 120 g / tree (N_4) recorded maximum potassium content in leaf (1.14 %) at fruit harvest stage, which was significantly superior to all remaining levels of nitrogen. The minimum leaf potassium content (0.90 %) was produced by the plant raised under application of nitrogen @ 60 g / tree (N_1).

The application of vermicompost also brought significant improvement towards total potassium content in leaves during both years. On the basis of pooled data plant getting the *In-situ* vermicomposting produced significantly highest total potassium content (1.06%) in leaves which was statistically better than the rest of the vermicompost treatment (*i.e.* application of vermicompost @ 4.0 kg/tree - V_1 and plant grown without Vermicompost - V_0).

Pooled analysed of data revealed that the application of *Azotobacter* showed significant variation in total potassium content in leaves at fruit harvest. Maximum potassium content in leaf (1.03%) at fruit harvest was recorded with the application of *Azotobacter* @ 200 g/tree, which was significantly superior over without application of *Azotobacter* (A_0).

4.1.6. Effects of nitrogen, vermicompost and *Azotobacter* on soil fertility status and microbial population at the depth of 0-30 cm after fruit harvest

Data pertaining to soil fertility status *i.e.* soil pH, EC, organic carbon, available nitrogen, P_2O_5 and K_2O and microbial population *i.e.* *Azotobacter*, bacterial and fungal at soil depth of 0-30 cm as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been also given in Table 4.6a and 4.6b and graphically illustrated in Fig.4.8.

An examination of data revealed that the various levels of nitrogen caused significant variation in soil pH at the depth of 0-30cm. The utmost value of soil pH (7.18) at the depth of 0-30cm was recorded with the application nitrogen @ 120g/tree (N_4), which was significantly superior with remaining levels nitrogen. The minimum soil pH (6.84) was noted under the treatment getting 60g nitrogen / tree (N_1).

The pooled analysed of data revealed that the soil pH at the depth of 0-30cm was influenced by different levels of vermicompost. *In-situ* vermicomposting (V_2) showed maximum soil pH (7.09) at the depth of 0-30cm, however, the minimum soil pH (6.93) was recorded with the presence of vermicompost @ 4.0 kg/tree (V_1) and without application of vermicompost (V_0).

The perusal of data in respect of soil electrical conductivity revealed that the main effect of nitrogen on soil electrical conductivity (dS/m) at the depth of 0-30cm was found significant. The maximum soil electrical conductivity (0.286 dS/m) at the depth of 0-30cm was noted with the application of nitrogen @ 100g/tree (N_3). The minimum soil electrical conductivity (0.255 dS/m) at the depth of 0-30cm was recorded with the plant raised under nitrogen @ 120g/tree (N_4).

Vermicomposting also showed pronounced variation in EC at the depth of 0-30cm. The plant getting the *In-situ* vermicomposting (V_2) and vermicompost @ 4.0 kg / tree (V_1) gave highest soil electrical conductivity (0.274 dS/m) , while lowest soil electrical conductivity (0.264 dS/m) was recorded under the treatment without vermicomposting (V_0).

Soil organic carbon at the depth of 0-30cm significantly increased with increasing level of nitrogen from 60 to 120 g/tree during both the years. Pooled data indicated that the application of nitrogen @ 120 g / tree (N_4) recorded maximum (0.568%) soil organic carbon at the depth of 0-30cm ,which was significantly superior over rest of the levels of nitrogen (*i.e.* 60, 80 and 100 g/tree).

Table 4.6a: Effect of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dS/m)			Organic carbon(%)			Available N (Kg/ha)		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	6.85	6.82	6.84	0.272	0.27	0.271	0.525	0.535	0.53	301.39	304.76	303.07
Nitrogen @80g/tree (N ₂)	6.89	6.85	6.87	0.285	0.258	0.272	0.538	0.545	0.542	303.59	306.25	304.92
Nitrogen @100g/tree (N ₃)	7.01	7.08	7.05	0.295	0.277	0.286	0.553	0.553	0.553	305.51	307.50	306.51
Nitrogen @120g/tree (N ₄)	7.14	7.22	7.18	0.26	0.250	0.255	0.565	0.57	0.568	307.43	308.81	308.12
SEm_±	0.05	0.07	0.04	0.003	0.003	0.003	0.005	0.006	0.004	1.14	0.89	0.73
CD (P=0.05)	0.14	0.19	0.12	0.008	0.008	0.006	0.016	0.016	0.011	3.26	2.54	2.04
Vermicompost level												
vermicomposting 0kg/tree (V ₀)	6.91	6.94	6.93	0.266	0.263	0.264	0.504	0.508	0.506	302.70	305.18	303.94
vermicomposting 4.0kg/tree (V ₁)	6.93	6.94	6.93	0.294	0.255	0.274	0.539	0.548	0.543	304.03	306.65	305.34
In-situ vermicomposting (V ₂)	7.08	7.10	7.09	0.274	0.274	0.274	0.594	0.598	0.596	306.71	308.65	307.68
SEm_±	0.04	0.06	0.04	0.003	0.002	0.003	0.005	0.005	0.004	0.99	0.77	0.63
CD (P=0.05)	0.13	NS	0.10	0.007	0.007	0.005	0.013	0.013	0.010	2.82	2.20	1.76
<i>Azotobacter</i> level												
<i>Azotobacter</i> 0g/tree (A ₀)	6.97	6.99	6.98	0.278	0.266	0.272	0.542	0.548	0.545	304.30	306.51	305.40
<i>Azotobacter</i> 200g/tree (A ₁)	6.98	7.00	6.99	0.278	0.262	0.270	0.549	0.554	0.552	304.66	307.15	305.91
SEm_±	0.04	0.05	0.03	0.002	0.002	0.002	0.004	0.004	0.003	1.98	0.63	0.51
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

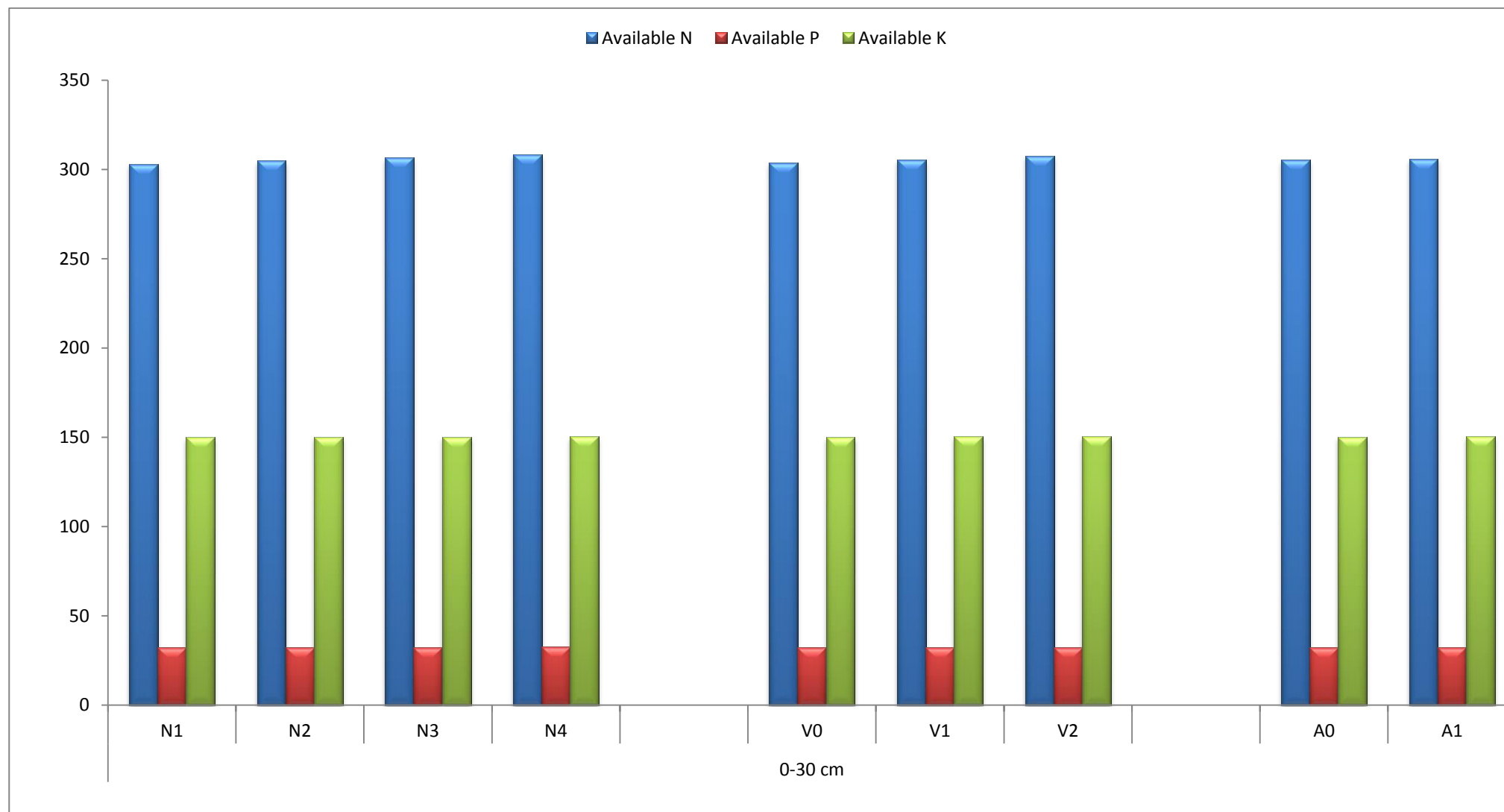


Fig.4.8: Effect of nitrogen, vermicompost and *Azotobacter* application on available N, P_2O_5 and K_2O status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Vermicomposting also showed significant impact towards soil organic carbon at the depth of 0-30cm. The maximum soil organic carbon (0.996%) at the depth of 0-30cm was noted with the application of *In-situ* vermicomposting (V_2) followed by vermicomposting @ 4 kg/tree and treatment without vermicomposting.

Each successive levels of nitrogen showed significant impact towards available nitrogen content in soil at 0-30 cm depth during both the years. Pooled data obviously indicated that the application of nitrogen @ 120 g / tree (N_4) recorded maximum available nitrogen content (308.12 kg / ha) in soil which was statistically similar to nitrogen @ 80 g / tree (304.92 kg / ha) and 100 g / tree 306.51 kg / ha.

The minimum value of available nitrogen content (303.07 kg / ha) in soil at 0 - 30 cm depth was noted with the application of nitrogen @ 60 g / tree (N_1).

The application of vermicompost brought significant impact towards soil nitrogen content at the soil depth 0 – 30 cm. According to pooled data, the highest (307.68 kg/ha) soil nitrogen content at the soil depth 0-30cm was recorded under *In-situ* vermicomposting (V_2), which was statistically similar to vermicomposting @ 4.0 kg / ha (305.34 kg/ha). The lowest soil nitrogen content (303.94 kg/ha) at the soil depth 0-30cm was noted under the treatment without vermicomposting (V_0).

A perusal of pooled data indicates that each increasing levels of nitrogen brought significant improvement towards phosphorus content in soil at the depth (0-30cm). The maximum phosphorus content (32.53 kg/ha) of soil at the depth 0-30cm was noted with application of nitrogen @ 120 g/tree (N_4), which was statistically at par with the (N_3) nitrogen @100g/tree (32.37 kg / ha). The minimum phosphorus (32.12 kg/ha) content of soil at the depth 0-30cm was noted with the application of nitrogen @ 60 g/ tree (N_1).

Vermicomposting showed the significant effect on phosphorus content of soil at the depth 0-30cm. The significantly highest phosphorus (32.46 kg / ha) content in soil at the depth 0-30cm was observed with *In-situ* vermicomposting (V_2) which was statistically at par with vermicomposting @ 4.0 kg / tree (V_1) that produced phosphorus content as 32.32 kg / ha. However, the lowest phosphorus content (32.19 kg/ha) was noted under the treatment without vermicompost (V_0).

The perusal of data in respect of available potassium content in soil at depth 0-30 revealed that the main effect of nitrogen, vermicompost and *Azotobacter* did not touch the level of significance.

Azotobacter count also varied significantly due to various levels of nitrogen. The utmost value of *Azotobacter* count (12.2×10^4 /g soil) was recorded with the application nitrogen @ 120g/tree, which was significantly superior to remaining levels nitrogen, whereas, the minimum *Azotobacter* count (8.1×10^4 /g soil) was noted with plant grown under 60g nitrogen per tree.

The *Azotobacter* count was influenced by different levels of vermicompost. The application of *In-situ* vermicomposting produced significantly maximum *Azotobacter* count (10.4×10^4 /g soil). The minimum *Azotobacter* count (9.0×10^4 /g soil) was recorded under the treatment without vermicomposting.

A perusal of data indicates that *Azotobacter* caused significant variation in *Azotobacter* count at depth of 0-30 cm. Application of 200g of *Azotobacter* per tree significantly higher *Azotobacter* count (10.3×10^4 /g soil) than without application of *Azotobacter* (9.1×10^4 /g soil).

Bacterial count under the influence of varying levels of nitrogen at the depth of 0-30cm varied significantly during both of years. On the basis of pooled data the maximum bacterial count (2.94×10^6 /g soil) at the depth of 0-30cm was recorded when nitrogen was applied @ 120g/ tree, however, the minimum bacterial count (2.72×10^6 /g soil) was obtained with the application of nitrogen @ 60 g/tree (N_1).

The data in respect of bacterial count at the depth of 0-30cm indicated that the main effect of vermicompost was found to be significant. The plant getting the *In-situ* vermicomposting gave significantly highest bacterial count (2.82×10^6 /g soil) at the depth of 0-30cm fallowed by (V_1) vermicomposting @ 4.0 kg/tree (2.70×10^6 /g soil) and (V_0) the treatment without vermicomposting (2.58×10^6 /g soil)

Various levels of *Azotobacter* brought significant variation in bacterial count at the depth of 0-30cm. The maximum bacterial count (2.74×10^6 /g soil) at the depth of 0-30cm was recorded with the application of *Azotobacter* @ 200 g/tree (A_1), whereas, the minimum bacterial count (2.66×10^6 /g soil) was noted under the treatment without *Azotobacter* (A_0).

The fungal count at the depth of 0-30cm influenced significantly due to different levels of nitrogen during both years. . On the basis of pooled data the highest fungal count at the depth of 0-30cm (9.01×10^4 /g soil) was noted with application of nitrogen @ 120 g/ tree (N_4) which was showed superiority over remaining levels of nitrogen. The lowest fungal count (6.43×10^4 /g soil) was noted with application of nitrogen @ 60g/tree (N_1).

An examination of data revealed that the vermicomposting caused significant variation on fungal count at the depth of 0-30cm. The highest fungal count (8.47×10^4 /g soil) was observed with the application of *In-situ* vermicomposting (V_2), however, the lowest fungal count (7.19×10^4 /g soil) was noted under the treatment without vermicomposting (V_0).

A perusal of data indicates that the main effect of *Azotobacter* caused the significant effect on fungal count at the depth of 0-30cm. The maximum fungal count at the depth of 0-30cm (7.99×10^4 /g soil) was found with the application of *Azotobacter* @ 200g/tree (A_1) whereas; the minimum fungal count at the depth of 0-30cm (7.68×10^4 /g soil) was found in the absence of *Azotobacter* (A_0).

It is clear from the pooled data that the various parameters regarding fertility status (P^H , EC, organic carbon, available N, P,K; *Azotobacter*, bacterial and fungal count of soil) did not touch the level of significance.

4.1.7. Effects of nitrogen, vermicompost and *Azotobacter* on soil fertility status and microbial population at the depth of 30-60 cm after fruit harvest

Data concerning to soil fertility status *i.e.* soil pH, EC, organic carbon, available nitrogen, P_2O_5 and K_2O and microbial population *i.e.* *Azotobacter*, bacterial and fungal at soil depth of 30-60 cm as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been also given in Table 4.7a and 4.7b and graphically illustrated in Fig. 4.9

Each successive levels of nitrogen showed significant impact towards soil pH at the depth of 30-60cm. Pooled data obviously indicated that the maximum soil pH (7.44) at the depth of 30-60cm was noted with the application of nitrogen @ 120 g/tree (N_4) which was statistically similar with the application of (N_3) nitrogen @ 100g/tree (7.35) and the minimum soil pH (7.25) at the depth of 30-60cm was produced by under nitrogen @ 60 g/tree (N_1).

Soil electrical conductivity at the depth of 30-60cm varied significantly and recorded the maximum value (0.228 dS m^{-1}) under nitrogen @ 100g/tree (N_3), which was statistically at par with the application of nitrogen @ 80 g / tree (N_2) while; the minimum soil electrical conductivity (0.218 dS m^{-1}) was noticed with application of nitrogen @ 120g/tree (N_4).

Each successive levels of nitrogen (60-120 g/plant) significantly increased the soil organic carbon at the depth of 30-60cm during both of the years as well as pooled over two

years. The plant receiving nitrogen @ 120 g/tree (N_4) attained significantly maximum per cent of soil organic carbon (0.407 %) at the depth of 30-60cm, which was significantly superior to all remaining doses of nitrogen. The minimum per cent soil organic carbon (0.371 %) was obtained under the treatment receiving nitrogen @ 60 g/tree (N_1).

It was noticed that the application of vermicompost brought significant variation with respect to soil organic carbon at the depth of 30-60cm. The plant getting *In-situ* vermicompost (V_2) noted significantly higher soil organic carbon (0.417 %) ,which was significantly superior to V_1 (application of vermicompost @ 4.0 kg/tree) and V_0 (without vermicompost). *Azotobacter* also caused significant variation in soil organic carbon at the depth of 30-60cm. The maximum soil organic carbon (0.390 %) was recorded when *Azotobacter* was applied @ 200 g/tree, however, the minimum soil organic carbon (0.381 %) was noted under the treatment without *Azotobacter* (A_0).

Each successive levels of nitrogen showed significant impact towards available nitrogen content in soil at 30-60 cm depth during both the years. Pooled data obviously indicated that the application of nitrogen @ 120 g/tree (N_4) recorded maximum available nitrogen content (139.12 kg/ha) in soil which was statistically similar with nitrogen @ 100 g/tree (137.40 kg/ha), whereas; the minimum value of available nitrogen content (134.07 kg/ha) was noted with the application of nitrogen @ 60 g/tree (N_1).

Vermicomposting brought significant impact towards soil nitrogen content (kg/ha) at the soil depth 30-60cm. According to pooled data, the highest (138.66 kg/ha) soil nitrogen content was recorded under *In-situ* vermicomposting (V_2), which was statistically superior to vermicomposting @ 4.0 kg/tree (V_1) and without vermicomposting (V_0).

Data indicated that the each successive levels of nitrogen (60-120g/plant) significantly increased the phosphorus content in soil at the depth 30-60cm during both the years as well as pooled over two years. The plant receiving nitrogen @ 120 g/tree (N_4) gave significantly maximum phosphorus content (14.69 kg/ha) of soil \,which was statistically higher than all other levels of nitrogen. Minimum value was noted with nitrogen @ 60 g/tree. The minimum phosphorus content in soil at the depth 30-60cm (14.11 kg/ha) was obtained with the plant receiving nitrogen @ 60 g/tree (N_1).

Table 4.7a: Effect of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dS/m)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen level												
Nitrogen @60g/tree (N ₁)	7.22	7.28	7.25	0.248	0.197	0.222	0.367	0.375	0.371	133.39	134.76	134.07
Nitrogen @80g/tree (N ₂)	7.26	7.29	7.28	0.250	0.196	0.223	0.375	0.380	0.378	135.54	135.92	135.73
Nitrogen @100g/tree (N ₃)	7.32	7.39	7.35	0.255	0.202	0.228	0.383	0.392	0.388	137.29	137.50	137.40
Nitrogen @120g/tree (N ₄)	7.42	7.47	7.44	0.247	0.190	0.218	0.402	0.412	0.407	139.43	138.81	139.12
SEm_±	0.04	0.06	0.03	0.003	0.003	0.002	0.004	0.005	0.003	0.70	0.61	0.46
CD (P=0.05)	0.11	NS	0.10	NS	NS	0.005	0.012	0.013	0.009	2.00	1.73	1.31
Vermicompost level												
vermicomposting 0kg/tree (V ₀)	7.31	7.32	7.31	0.252	0.190	0.221	0.344	0.353	0.348	134.54	135.18	134.86
vermicomposting 4.0kg/tree (V ₁)	7.32	7.40	7.36	0.248	0.199	0.223	0.389	0.395	0.392	136.03	136.40	136.21
In-situ vermicomposting (V ₂)	7.29	7.35	7.32	0.250	0.200	0.225	0.413	0.421	0.417	138.68	138.65	138.66
SEm_±	0.03	0.05	0.03	0.002	0.002	0.002	0.004	0.004	0.003	0.61	0.53	0.40
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.010	0.011	0.008	1.73	1.50	1.13
<i>Azotobacter</i> level												
<i>Azotobacter</i> 0g/tree (A ₀)	7.28	7.34	7.31	0.251	0.197	0.224	0.377	0.385	0.381	136.16	136.51	136.33
<i>Azotobacter</i> 200g/tree (A ₁)	7.33	7.37	7.35	0.249	0.196	0.222	0.387	0.394	0.390	136.66	136.98	136.82
SEm_±	0.03	0.04	0.03	0.002	0.002	0.001	0.003	0.003	0.002	0.50	0.43	0.33
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.008	NS	0.006	NS	NS	NS

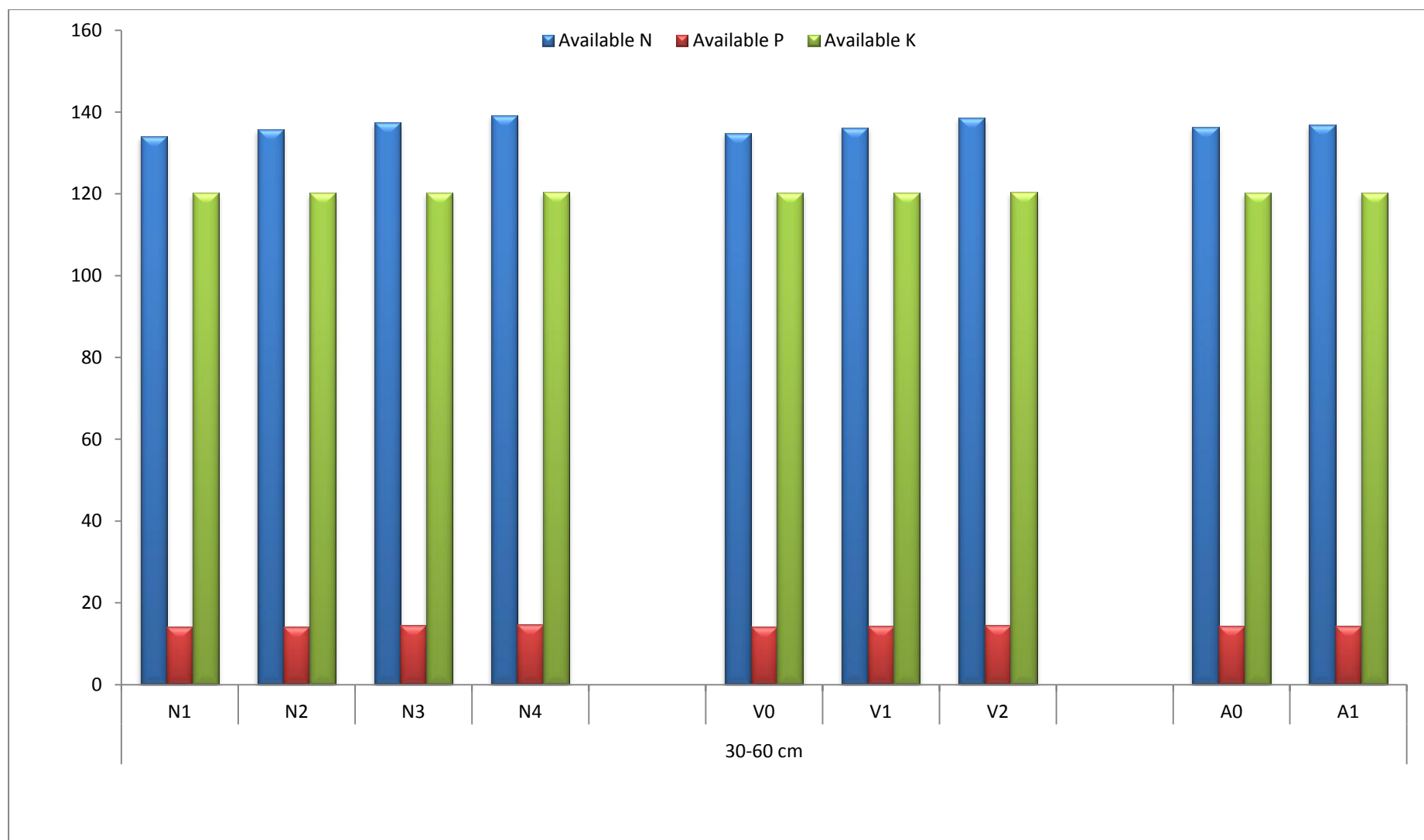


Fig.4.9: Effect of nitrogen, vermicompost and *Azotobacter* application on available N, P₂O₅ and K₂O status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Table 4.7b: Effect of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ g/soil)			Bacterial population (× 10 ⁶ g/soil)			Fungal population (× 10 ⁴ g/soil)		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	13.65	14.56	14.11	119.36	121.01	120.18	5.37	5.40	5.38	1.68	1.69	1.69	4.57	4.63	4.60
Nitrogen @80g/tree (N ₂)	13.75	14.67	14.21	119.40	121.05	120.22	5.45	5.54	5.49	2.00	2.02	2.01	4.94	5.00	4.97
Nitrogen @100g/tree (N ₃)	14.10	14.89	14.49	119.52	121.10	120.31	5.61	5.68	5.64	2.24	2.26	2.25	5.19	5.26	5.22
Nitrogen @120g/tree (N ₄)	14.22	15.16	14.69	119.61	121.15	120.38	5.76	5.87	5.81	2.29	2.31	2.30	5.64	5.71	5.67
SEm±	0.13	0.12	0.09	0.74	0.88	0.58	0.05	0.05	0.04	0.01	0.01	0.01	0.05	0.05	0.04
CD (P=0.05)	0.37	0.33	0.25	NS	NS	NS	0.16	0.14	0.10	0.03	0.03	0.02	0.14	0.14	0.10
Vermicompost level															
vermicomposting 0kg/tree (V ₀)	13.82	14.68	14.25	119.35	121.00	120.17	5.40	5.47	5.43	1.96	1.97	1.96	4.70	4.77	4.73
vermicomposting 4.0kg/tree (V ₁)	13.92	14.82	14.37	119.49	121.08	120.28	5.52	5.59	5.55	2.05	2.07	2.06	5.12	5.19	5.16
In-situ vermicomposting (V ₂)	14.05	14.96	14.50	119.58	121.15	120.37	5.71	5.81	5.76	2.15	2.17	2.16	5.43	5.49	5.46
SEm±	0.11	0.10	0.08	0.64	0.77	0.50	0.05	0.04	0.03	0.01	0.01	0.01	0.04	0.04	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.14	0.12	0.09	0.03	0.02	0.02	0.12	0.12	0.09
<i>Azotobacter</i> level															
<i>Azotobacter</i> 0g/tree (A ₀)	13.91	14.79	14.35	119.45	121.06	120.25	5.42	5.49	5.46	2.03	2.05	2.04	5.00	5.07	5.04
<i>Azotobacter</i> 200g/tree (A ₁)	13.95	14.85	14.40	119.50	121.09	120.29	5.67	5.75	5.71	2.08	2.09	2.09	5.17	5.23	5.20
SEm±	0.09	0.08	0.06	0.53	0.62	0.41	0.04	0.03	0.03	0.01	0.01	0.01	0.04	0.04	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.11	0.10	0.07	0.02	0.02	0.02	0.10	0.10	0.07

Azotobacter count at the depth of 30-60 cm varied significantly due to various levels of nitrogen. The maximum *Azotobacter* count (5.81×10^4 /g soil) was noted with the application of nitrogen @ 120 g/tree (N_4), which was outstanding significantly superior to all remaining levels of nitrogen. The minimum *Azotobacter* count (5.38×10^4 /g soil) was noted with the application of nitrogen @ 60 g/tree (N_1).

Vermicomposting significantly influenced the *Azotobacter* count at the depth of 30-60 cm during both years.. On the basis of pooled data the plant getting the *In-situ* vermicomposting produces significantly highest *Azotobacter* count (5.76×10^4 /g soil while; lowest *Azotobacter* count (5.43×10^4 /g soil) was recorded under without vermicomposting.

Maximum *Azotobacter* count (5.67×10^4 /g soil and 5.75×10^4 /g soil) was recorded at the depth of 30-60 cm during both the years, which showed most superiority over without *Azotobacter* (A_0) that gave the value of *Azotobacter* count 5.42×10^4 /g soil and 5.49×10^4 /g soil.

Various levels of nitrogen caused significant variation regarding bacterial count at the depth of 30-60cm. The maximum bacterial count (2.30×10^6 /g soil) was noted with the application nitrogen @ 120 g/tree (N_4) which was found outstanding being significant superior to all the levels of nitrogen. The lowest bacterial count (1.69×10^6 /g soil) was noticed with application of nitrogen @ 60g/tree (N_1).

The data in respect of bacterial count at the depth of 30-60 cm varied significantly due to vermicomposting. According to pooled data the maximum bacterial count (2.16×10^6 /g soil) was noted with the application of *In-situ* vermicomposting (V_2). However; the lowest bacterial count (1.96×10^6 /g soil) was observed under the treatment without vermicomposting.

The application of *Azotobacter* brought the significant impact towards on bacterial count at the depth of 30-60cm. The maximum bacterial count (2.09×10^6 /g soil) was recorded with the application of *Azotobacter* @ 200g/tree (A_1) and the minimum (2.04×10^6 /g soil) was obtained in the absence of *Azotobacter* (A_0).

The perusal of data indicated that main effect of levels of nitrogen showed the significant effect on fungal count at the depth of 30-60cm. The highest fungal count (5.67×10^4 /g soil) was noted with application of nitrogen @ 120g/tree (N_4) which showed most superiority over 60 to 100 g of nitrogen. The lowest fungal count (4.60×10^4 /g soil) was noted with application of nitrogen @ 60 g/tree (N_1).

Pooled data indicated that the vermicomposting brought pronounced effect on fungal count and recorded highest fungal count (5.46×10^4 /g soil) under *In-situ* vermicomposting (V_2). The lowest fungal count (4.73×10^4 /g soil) was noted under without vermicomposting (V_0).

A perusal of data indicates that the main effect of *Azotobacter* also caused the significant effect on fungal count at the depth of 30-60cm. The maximum fungal count (5.20×10^4 /g soil) was found with the application of *Azotobacter* @ 200 g/tree (A_1) whereas; the minimum fungal count (5.04×10^4 /g soil) was found in the absence of *Azotobacter* (A_0).

4.1.8. Effects of nitrogen, vermicompost and *Azotobacter* on soil fertility status and microbial population at the depth of 60-90 cm after fruit harvest

Data concerning to soil fertility status *i.e.* soil pH, EC, organic carbon, available nitrogen, P_2O_5 and K_2O and microbial population *i.e.* *Azotobacter*, bacterial and fungal at soil depth of 60-90 cm as influenced by various levels of nitrogen, vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been also given in Table 4.8a and 4.8b -and graphically illustrated in Fig.4.10.

The application of nitrogen did not bring tangible impact towards P^H of the soil however, brought significant impact towards soil electrical conductivity at the depth of 60-90cm. The maximum soil electrical conductivity (0.194 dS m^{-1}) was noted with the application of nitrogen @ 60 g/ tree (N_1), which was statistically similar to nitrogen @ 100 g/tree. The lowest soil electrical conductivity (0.169 dS m^{-1}) was noted with application of nitrogen @ 120 g/tree (N_4).

The electrical conductivity at the depth of 60-90 cm influenced significantly due to various levels of vermicomposting. On the basis of pooled data, the highest soil electrical conductivity (0.189 dS m^{-1}) was noted under without application vermicomposting (V_0). The lowest soil electrical conductivity (0.183 dS m^{-1}) was noted with application of *In-situ* vermicomposting (V_2).

Azotobacter also showed the significant effect on soil electrical conductivity at the depth of 60-90cm. The maximum soil electrical conductivity (0.207 dS m^{-1}) was found with the application of *Azotobacter* @ 200g/tree (A_1).

The soil organic carbon at the depth of 60-90cm significantly varied with increasing level of nitrogen during both the years. Pooled data over two years showed that the maximum soil organic carbon (0.182) was obtained with the application of nitrogen @ 120 g/tree (N_4), which was significantly superior over all remaining levels of nitrogen. The minimum soil organic carbon (0.143 %) was obtained under nitrogen level of 60 g/tree (N_1).

On the basis of pooled data, the plant getting *In-situ* vermicompost noted significantly highest soil organic carbon (0.186), which was significantly more over the

Table 4.8a: Effect of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dS/m)			Organic carbon (%)			Available N (Kg/ha)		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	7.12	7.41	7.27	0.239	0.148	0.194	0.143	0.143	0.143	80.84	81.53	81.19
Nitrogen @80g/tree (N ₂)	7.13	7.36	7.24	0.235	0.143	0.189	0.147	0.155	0.151	81.45	82.25	81.85
Nitrogen @100g/tree (N ₃)	7.19	7.43	7.31	0.248	0.131	0.190	0.160	0.167	0.163	83.06	83.86	83.46
Nitrogen @120g/tree (N ₄)	7.13	7.33	7.23	0.218	0.120	0.169	0.178	0.185	0.182	84.44	85.06	84.75
SEm±	0.05	0.09	0.05	0.002	0.002	0.001	0.002	0.002	0.001	0.84	0.21	0.43
CD (P=0.05)	NS	NS	NS	0.007	0.004	0.004	0.005	0.005	0.003	2.40	0.61	1.22
Vermicompost level												
vermicomposting 0kg/tree (V ₀)	7.12	7.35	7.24	0.241	0.137	0.189	0.136	0.139	0.138	81.66	82.21	81.94
vermicomposting 4.0kg/tree (V ₁)	7.17	7.41	7.29	0.232	0.136	0.184	0.153	0.159	0.156	82.34	82.98	82.66
In-situ vermicomposting (V ₂)	7.13	7.39	7.26	0.233	0.134	0.183	0.183	0.190	0.186	83.35	84.33	83.84
SEm±	0.05	0.07	0.04	0.002	0.001	0.001	0.002	0.001	0.001	0.73	0.19	0.38
CD (P=0.05)	NS	NS	NS	0.006	NS	0.004	0.004	0.004	0.002	NS	0.53	1.06
<i>Azotobacter</i> level												
<i>Azotobacter</i> 0g/tree (A ₀)	7.16	7.40	7.28	0.232	0.133	0.183	0.152	0.158	0.155	82.31	83.01	82.66
<i>Azotobacter</i> 200g/tree (A ₁)	7.12	7.36	7.24	0.238	0.138	0.188	0.163	0.168	0.165	82.58	83.34	82.96
SEm±	0.04	0.06	0.04	0.002	0.001	0.001	0.001	0.001	0.001	0.60	0.15	0.31
CD (P=0.05)	NS	NS	NS	0.012	0.003	0.003	0.004	0.003	0.002	NS	NS	NS

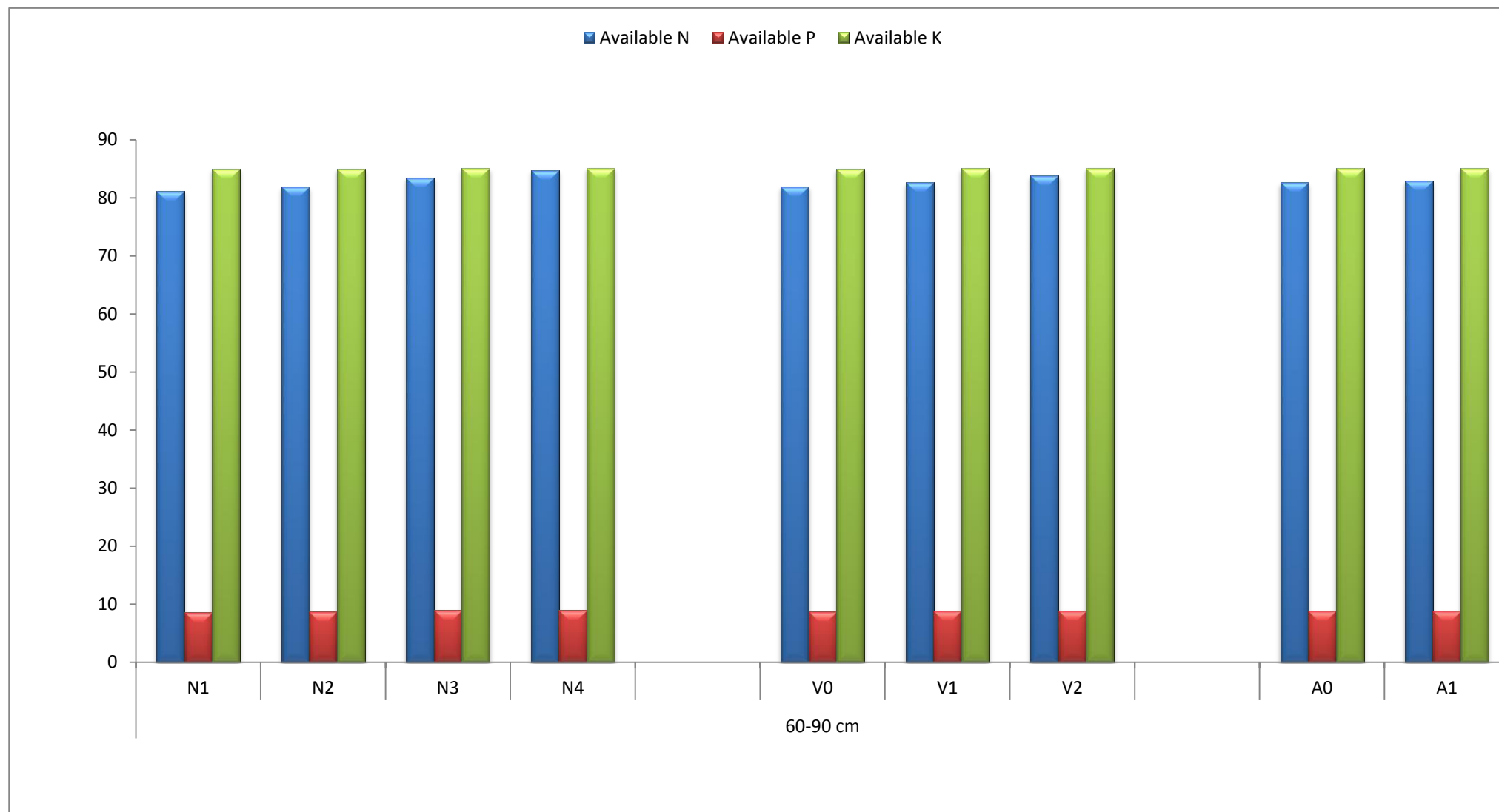


Fig.4.10: Effect of nitrogen, Vermicompost and *Azotobacter* application on available N, P_2O_5 and K_2O status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

application of vermicompost @ 4.0 kg/tree (V_1) and plant grown without vermicompost (V_0). However, the lowest soil organic carbon (0.138%) recorded under the treatment without vermicomposting (V_0)

The data revealed that the application of *Azotobacter* brought significant variation in soil organic carbon at the depth of 60-90cm. Pooled data indicated that the maximum soil organic carbon (0.165 %) was recorded with the application of *Azotobacter* @ 200 g/tree (A_1), whereas, the minimum soil organic carbon (0.155 %) was noted under the treatment without *Azotobacter* (A_0).

The perusal of revealed that the each successive levels of nitrogen showed significant impact towards available nitrogen content in soil at depth of 60-90cm during both of the years. Pooled data obviously indicated that the application of nitrogen @ 120 g/tree (N_4) recorded maximum nitrogen content (84.75 kg/ha), which was significantly superior to all remaining levels of nitrogen. The minimum nitrogen content (81.19 kg/ha) was produced by the plant raised under application of nitrogen @ 60 g/tree (N_1).

The application of vermicompost also brought significant improvement towards nitrogen content (kg/ha) at soil depth 60-90cm. The plant getting the *In-situ* vermicomposting produced significantly highest nitrogen content (83.84 kg/ha), which was statistically better than the rest of the vermicompost treatment (*i.e.* application of vermicompost @ 4.0 kg/tree (V_1) and plant grown without vermicompost (V_0)).

An examination of the data revealed that the available phosphorus content of soil at the depth 60-90cm significantly increased with increasing level of nitrogen during both the years. According to pooled data over two years, the maximum phosphorus content (8.97 kg/ha) was noted with the application of nitrogen @ 120 g/tree (N_4), which was statistically at par with 8.88 kg/ha resulted with the application of nitrogen @ 100g/tree (N_3), whereas; the minimum available phosphorus content of soil (8.56 kg/ha) was obtained with the plant raised under nitrogen level of 60 g/tree (N_1).

On the basis of pooled data, the plant getting *In-situ* vermicompost produced significantly highest available phosphorus content (8.87 kg/ha), which was found statistically at par with vermicomposting @ 4.0 kg/tree. However, the treatment without vermicomposting (V_0) recorded the lowest available phosphorus content in soil *i.e.* 8.67 kg/ha.

The data in respect of *Azotobacter* count at the depth of 60-90 cm was varied significantly due to different levels of nitrogen during both years. The plant grown under

application of nitrogen @ 120 g/tree (N_4) produced significantly maximum *Azotobacter* count (2.16×10^4 /g soil) which was found statistically at par with the application of nitrogen @ 80g/tree and 100g/tree that gave *Azotobacter* count 2.15×10^4 /g soil and 2.14×10^4 /g soil respectively. The minimum *Azotobacter* count (2.11×10^4 /g soil) was produced by the plant raised under application of nitrogen @ 60 g/tree (N_1).

The perusal of data in respect of bacterial count at the depth of 60-90 cm revealed that the main effect of nitrogen touched the levels of significance. The highest bacterial count (1.25×10^6 /g soil) was noted with application of nitrogen @ 120 g/tree (N_4), which showed most superiority with remaining levels of nitrogen. The lowest bacterial count (0.93×10^6 /g soil) was noted with application of nitrogen @ 60 g/ tree (N_1).

It is evident of from the variance that the bacterial count at the depth of 60-90cm was influenced significantly by different levels of vermicompost. The highest bacterial count (1.14×10^6 /g soil) was noted with application of *In-situ* vermicomposting (V_2), however, the lowest bacterial count (1.06×10^6 /g soil) was noted without application of vermicompost (V_0).

The fungal count at the depth of 60-90 cm was significantly influenced by levels of nitrogen. The plant grown with nitrogen @ 120 g/tree (N_4) produced significantly maximum fungal count (2.65×10^4 /g soil) which was significantly superior to all remaining levels of nitrogen. The minimum fungal count (2.14×10^4 /g soil) was produced under application of nitrogen @ 60 g/tree (N_1).

The plant getting *In-situ* vermicomposting produced maximum fungal count (2.40×10^4 /g soil), which was significantly superior over V_1 (application of vermicompost @ 4.0kg/tree) and V_0 (without vermicompost). Lowest fungal count (2.29×10^4 /g soil) was recorded in plant grown without vermicompost (V_0).

Azotobacter also caused significant variation in fungal count at the depth of 60-90cm. Maximum fungal count (2.35×10^4 /g soil) was recorded with the application of *Azotobacter* @ 200 g/tree. This was found statistically at par with that in the absence of *Azotobacter* (A_0) which gave 2.32×10^4 /g soil fungal count at the depth of 60-90cm.

4.2. Interaction effect of nitrogen and *Azotobacter*

4.2.1 Interaction effect of nitrogen and vermicompost on Phenological observations

Interaction effect due to nitrogen and *Azotobacter* did not show any significant improvement towards all phonological parameters *i.e.* plant height increased (%), plant Spread N-S (%), plant Spread E-W (%) canopy volume (cm^3) during both the years as well as pooled (Table 4.9).

Table 4.8b: Effect of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 60-90 cm soil depth after harvest of mango cv.Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
Nitrogen level	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Nitrogen @60g/tree (N ₁)	8.36	8.77	8.56	84.71	85.29	85.00	2.07	2.15	2.11	0.92	0.94	0.93	2.12	2.15	2.14
Nitrogen @80g/tree (N ₂)	8.47	8.84	8.66	84.75	85.34	85.04	2.13	2.17	2.15	1.07	1.08	1.08	2.19	2.22	2.20
Nitrogen @100g/tree (N ₃)	8.79	8.97	8.88	84.81	85.38	85.10	2.13	2.15	2.14	1.14	1.15	1.14	2.32	2.38	2.35
Nitrogen @120g/tree (N ₄)	8.89	9.06	8.97	84.86	85.47	85.16	2.14	2.18	2.16	1.25	1.26	1.25	2.62	2.67	2.65
SEm±	0.10	0.07	0.06	0.02	0.71	0.47	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
CD (P=0.05)	0.27	0.19	0.16	NS	NS	NS	0.04	0.03	0.02	0.03	0.03	0.02	0.05	0.06	0.04
Vermicompost level															
vermicomposting 0kg/tree (V ₀)	8.55	8.80	8.67	84.72	85.28	85.00	2.14	2.16	2.15	1.05	1.06	1.06	2.28	2.31	2.29
vermicomposting 4.0kg/tree (V ₁)	8.62	8.91	8.76	84.77	85.38	85.08	2.13	2.16	2.14	1.09	1.10	1.10	2.29	2.33	2.31
In-situ vermicomposting (V ₂)	8.72	9.03	8.87	84.85	85.45	85.15	2.09	2.17	2.13	1.14	1.15	1.14	2.37	2.42	2.40
SEm±	0.08	0.06	0.05	0.54	0.61	0.41	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
CD (P=0.05)	NS	0.17	0.14	NS	NS	NS	0.03	NS	NS	0.03	0.03	0.02	0.05	0.05	0.03
<i>Azotobacter</i>															
<i>Azotobacter</i> 0g/tree (A ₀)	8.61	8.88	8.75	84.77	85.36	85.06	2.13	2.16	2.14	1.09	1.09	1.09	2.30	2.34	2.32
<i>Azotobacter</i> 200g/tree (A ₁)	8.64	8.94	8.79	84.79	85.38	85.09	2.11	2.17	2.14	1.10	1.11	1.11	2.33	2.37	2.35
SEm±	0.07	0.05	0.04	0.44	0.50	0.33	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.02	NS	NS	0.03

4.2.2. Interaction effect of nitrogen and *Azotobacter* on fruiting behaviour

Table 4.10 revealed that the combined use of nitrogen and *Azotobacter* failed to touch the level of significance with regard to fruit set, fruit drop and fruit retention during both the years as well as pooled.

4.2.3. Interaction effect of nitrogen and *Azotobacter* on physical parameters of fruit and yield:

Data regarding physical parameters (fruit weight, fruit length, fruit width, fruit volume, fruit specific gravity, pulp weight, stone weight, peel weight, pulp percent, pulp stone ratio, pulp peel ratio, fruits/tree and yield) as influenced by interactive use of N x A have been presented in Table 4.11a, 4.11b and 4.11c. Pooled over data for two years presented in tables indicated that none of the physical parameters varied significantly due to interactive use of N x A except fruit weight, pulp weight and stone weight, which were statistically significant and recorded maximum values 194.66 g, 125.85 g/fruit and 31.70g, respectively.

4.2.4. Interaction effect of nitrogen and *Azotobacter* on Biochemical and antioxidant compounds

All the biochemical and antioxidant parameters *i.e.* TSS, titrable acidity, TSS/acidity ratio, total sugar, total carotenoids and ascorbic acid content of fruit showed non-significance difference with the combined use of nitrogen and *Azotobacter* except TSS/acidity, which

Table 4.9: Interaction effect of level of nitrogen and *Azotobacter* on vegetative growth of mango cv. Amrapali under HDP

Treatment	Plant Height increased (%)			Plant Spread N-S (%)			Plant Spread E-W (%)			Canopy volume (m ³)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x A ₀	16.99	19.54	18.27	8.50	10.65	9.58	7.88	9.26	8.57	8.81	9.63	9.22
N ₂ x A ₀	17.74	21.03	19.39	9.49	13.00	11.25	8.94	10.97	9.95	10.10	11.02	10.56
N ₃ x A ₀	21.45	23.53	22.49	11.52	14.45	12.98	10.94	12.69	11.82	10.98	12.17	11.58
N ₄ x A ₀	28.14	29.51	28.83	12.91	15.77	14.34	12.21	13.99	13.10	11.72	14.58	13.15
N ₁ x A ₁	17.68	20.30	18.99	8.91	11.21	10.06	8.22	9.72	8.97	9.03	9.91	9.47
N ₂ x A ₁	19.17	21.22	20.20	9.83	13.28	11.56	9.26	11.27	10.27	10.39	11.24	10.81
N ₃ x A ₁	22.20	23.80	23.00	11.94	14.65	13.30	11.50	13.08	12.29	11.21	12.54	11.87
N ₄ x A ₁	29.15	30.08	29.62	13.51	16.64	15.07	12.76	14.70	13.73	12.06	13.69	12.87
SEm_±	0.51	0.67	0.42	0.26	0.31	0.20	0.30	0.41	0.25	0.31	0.43	0.27
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.10: Interaction effect of level of nitrogen and *Azotobacter* on fruiting behaviour of mango cv. Amrapali under HDP

Treatment	Fruit set (%)			Fruit drop (%)			Fruit retention (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	pooled
N ₁ x A ₀	9.00	9.02	9.01	94.94	91.48	93.21	5.06	8.51	6.78
N ₂ x A ₀	12.62	12.65	12.63	93.04	90.29	91.67	6.96	9.71	8.33
N ₃ x A ₀	16.90	16.94	16.92	91.11	89.31	90.21	8.89	10.69	9.79
N ₄ x A ₀	15.93	15.96	15.94	92.31	86.95	89.63	7.69	13.05	10.37
N ₁ x A ₁	9.31	9.33	9.32	94.83	91.56	93.19	5.17	8.44	6.81
N ₂ x A ₁	12.81	12.84	12.83	92.94	90.67	91.80	7.06	9.33	8.20
N ₃ x A ₁	17.19	17.21	17.20	90.99	89.43	90.21	9.01	10.68	9.85
N ₄ x A ₁	15.23	15.26	15.25	92.27	88.34	90.30	7.73	11.66	9.70
SEm_±	0.27	0.30	0.20	1.60	1.54	1.11	0.31	0.31	0.22
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.11 a: Interaction effect of level of nitrogen and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Fruit weight (g)			Fruit length (cm)			Fruit width (cm)			Volume (cm ³)			Specific gravity Fruit		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x A ₀	157.93	150.38	154.16	10.22	9.20	9.71	5.85	5.85	6.01	154.94	148.09	151.51	1.025	1.015	1.020
N ₂ x A ₀	173.66	166.51	170.08	10.59	9.44	10.01	6.30	6.30	6.15	170.21	163.82	167.01	1.020	1.017	1.018
N ₃ x A ₀	149.46	143.34	146.40	10.16	9.02	9.59	6.61	6.61	6.35	146.89	144.21	145.55	1.024	1.021	1.022
N ₄ x A ₀	189.99	183.14	186.57	10.81	9.64	10.23	6.68	6.68	6.60	187.05	181.50	184.28	0.992	1.008	1.000
N ₁ x A ₁	171.18	162.80	166.99	10.40	9.22	9.81	6.04	6.04	6.14	168.54	160.18	164.36	1.021	1.028	1.024
N ₂ x A ₁	172.92	163.07	167.99	10.56	9.42	9.99	6.50	6.50	6.43	172.49	160.94	166.72	1.023	1.013	1.018
N ₃ x A ₁	153.28	140.12	146.70	10.18	9.01	9.60	6.83	6.83	6.43	150.23	135.59	142.91	1.016	1.018	1.017
N ₄ x A ₁	199.17	190.14	194.66	11.06	9.90	10.48	6.90	6.90	6.71	196.14	187.94	192.04	1.019	1.017	1.018
SEm±	0.37	4.98	2.50	0.58	0.48	0.13	0.13	0.19	0.32	3.09	4.71	2.82	0.03	0.05	0.03
CD (P=0.05)	0.89	NS	7.01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.11 b: Interaction effect of level of nitrogen and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp weight (g/fruit)			Stone weight (g)			Peel weight (g)			Pulp percent		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ x A ₀	92.73	95.84	94.29	25.80	26.63	26.22	26.87	27.90	27.38	58.74	63.78	61.26
N ₂ x A ₀	106.57	109.96	108.26	27.03	28.20	27.61	27.34	28.35	27.85	61.45	66.11	63.78
N ₃ x A ₀	94.29	100.73	97.51	21.22	22.66	21.94	21.45	23.36	22.40	63.10	70.24	66.67
N ₄ x A ₀	118.04	121.56	119.80	29.75	30.82	30.29	29.77	30.76	30.26	62.13	66.39	64.26
N ₁ x A ₁	102.19	105.59	103.89	27.75	28.45	28.10	27.63	28.76	28.20	60.29	64.78	62.54
N ₂ x A ₁	107.81	109.65	108.73	26.22	26.42	26.32	26.38	27.00	26.69	62.33	67.28	64.80
N ₃ x A ₁	97.24	95.09	96.17	21.56	21.02	21.29	21.98	21.78	21.88	63.43	68.98	66.21
N ₄ x A ₁	124.21	127.49	125.85	31.40	32.01	31.70	31.17	31.76	31.46	62.37	66.48	64.42
SEm±	3.26	2.69	2.11	0.97	0.79	0.62	1.58	0.29	0.80	1.39	1.85	1.16
CD (P=0.05)	NS	7.66	5.93	NS	2.24	1.75	NS	0.82	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.11 c: Interaction effect of level of nitrogen and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp stone ratio			Pulp peel ratio			Number of fruit /tree			Yield (kg/tree)			Yield (t/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x A ₀	3.60	3.61	3.61	3.46	3.45	3.46	41.61	52.67	47.14	6.63	7.88	7.26	10.15	14.98	12.56
N ₂ x A ₀	3.96	3.92	3.94	3.91	3.90	3.91	46.23	59.00	52.62	7.83	9.69	8.76	12.47	17.41	14.94
N ₃ x A ₀	4.45	4.46	4.45	4.40	4.32	4.36	64.84	81.11	72.98	10.68	11.32	11.00	16.17	20.98	18.57
N ₄ x A ₀	3.97	3.95	3.96	3.97	3.95	3.96	52.69	61.67	57.18	10.01	11.28	10.65	16.29	20.61	18.45
N ₁ x A ₁	3.72	3.71	3.71	3.74	3.68	3.71	41.33	52.00	46.66	7.13	7.82	7.48	10.89	15.68	13.28
N ₂ x A ₁	4.13	4.16	4.14	4.10	4.07	4.08	47.85	61.67	54.76	8.15	10.00	9.08	12.65	17.49	15.07
N ₃ x A ₁	4.52	4.54	4.53	4.43	4.38	4.40	72.22	87.11	79.67	11.03	12.13	11.58	16.60	21.25	18.93
N ₄ x A ₁	3.97	3.95	3.96	3.99	3.98	3.98	50.29	60.67	55.48	10.01	11.55	10.78	15.82	20.67	18.25
SEm±	0.14	0.13	0.10	0.15	0.10	0.09	3.82	0.75	1.94	0.37	0.17	0.21	0.53	0.45	0.35
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	2.14	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.12 a: Interaction effect of level of nitrogen and *Azotobacter* on biochemical and antioxidant compounds of mango fruit cv. Amrapali under HDP

Treatment	TSS (^o B)			Titratable acidity (%)			TSS/Acidity		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x A ₀	20.73	20.74	20.73	0.253	0.248	0.250	84.89	85.77	85.33
N ₂ x A ₀	21.78	21.83	21.80	0.218	0.204	0.211	104.92	112.06	108.49
N ₃ x A ₀	23.18	23.24	23.21	0.178	0.169	0.174	136.17	143.99	140.08
N ₄ x A ₀	21.39	21.43	21.41	0.204	0.198	0.201	108.08	111.76	109.92
N ₁ x A ₁	20.90	20.89	20.90	0.238	0.232	0.235	89.54	90.28	89.91
N ₂ x A ₁	21.93	21.95	21.94	0.207	0.188	0.198	109.43	120.06	114.75
N ₃ x A ₁	23.35	23.41	23.38	0.159	0.152	0.155	151.04	158.57	154.80
N ₄ x A ₁	21.42	21.47	21.45	0.193	0.184	0.189	113.71	119.03	116.37
SEm±	0.25	0.24	0.17	0.003	0.002	0.002	1.68	0.88	0.95
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	2.50	2.66

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.12 b: Interaction effect of level of nitrogen and *Azotobacter* on biochemical and antioxidant compounds of mango fruit cv. Amrapali under HDP

Treatment	Total sugars (%)			Total Carotenoids (mg/100g pulp)			Ascorbic Acid content (mg/100 g pulp)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x A ₀	16.16	15.75	15.75	16.07	16.99	16.53	29.19	31.51	30.35
N ₂ x A ₀	17.26	16.99	16.98	17.15	17.76	17.45	33.98	34.16	34.07
N ₃ x A ₀	17.85	18.04	18.01	18.36	18.40	18.38	37.87	38.21	38.04
N ₄ x A ₀	17.32	17.46	17.43	17.59	17.59	17.59	37.05	37.12	37.08
N ₁ x A ₁	16.26	15.82	15.83	16.21	17.09	16.65	30.18	32.17	31.17
N ₂ x A ₁	17.38	17.35	17.20	17.25	17.82	17.53	34.17	34.23	34.20
N ₃ x A ₁	17.92	18.14	18.12	18.58	18.48	18.53	38.76	39.04	38.90
N ₄ x A ₁	17.37	17.52	17.49	17.66	17.64	17.65	37.03	37.14	37.08
SEm_±	0.15	0.12	0.10	0.17	0.10	0.10	0.43	0.38	0.28
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

gave maximum TSS/acidity ratio with the combined application of nitrogen @ 100 g/tree + *Azotobacter* @ 200 g/tree ($N_3 \times A_1$) during 2014-15, 2015-16 and pooled (Table 4.12a and 4.12b).

4.2.5. Interaction effect of nitrogen and *Azotobacter* on total nitrogen, phosphorus and potassium content in leaves

Data recorded on account of total nitrogen, phosphorus and potassium content in leaves as influenced by interactive use of nitrogen and *Azotobacter* during 2014-15, 2015-16 and pooled over two years have been given in Table 4.13.

Pooled data revealed that the highest total nitrogen (1.505 %) and phosphorus (0.128%) content in leaves was significantly higher with the combined application of nitrogen @ 120 g/tree along with *Azotobacter* @ 200 g/tree ($N_4 \times A_1$), which showed statistically similar effect with application of nitrogen @ 120 g/tree in the absence of *Azotobacter* ($N_4 \times A_0$) in case of total nitrogen content. Whereas, potassium content in leaves was observed statistically non-significance.

4.2.6. Interaction effect of nitrogen and *Azotobacter* on soil fertility status at 0-30 cm depth

Table 4.14a and 4.14b indicated that the soil fertility status (pH, EC, Organic carbon, available nitrogen, phosphorus and potassium) and microbial population (*Azotobacter*, bacterial and fungal) at 0-30 cm soil depth did not show any significant improvement due to interactive use of nitrogen and *Azotobacter* except EC and *Azotobacter* population (pooled over two years). The highest value of soil electrical conductivity (0.288 dS/m) was noted with the combined application of nitrogen @ 100 g/tree in the absence of *Azotobacter* ($N_3 \times A_0$), which statistically at par with $N_3 \times A_1$ i.e. application of nitrogen @ 100 g/tree along with *Azotobacter* @ 200 g/tree (0.283 dS/m).

Plant grown in interaction with the nitrogen @ 120 g/tree and *Azotobacter* @ 200 g/tree ($N_4 \times A_1$) counted maximum *Azotobacter* population (12.97×10^4 /g soil), which was significantly higher over the rest of combination. Whereas, the minimum *Azotobacter* count (7.88×10^4 /g soils) was recorded with the application of nitrogen @ 60 g/tree in the absence of *Azotobacter*.

4.2.7. Interaction effect of nitrogen and *Azotobacter* on soil fertility status at 30-60 cm depth

The data on soil fertility status (pH, EC, Organic carbon, available nitrogen, phosphorus and potassium) and microbial population (*Azotobacter*, bacterial and fungal) at 30-60 cm soil depth presented in Table 4.15a and 4.15b revealed that the soil fertility status

Table 4.13: Interaction effect of levels of nitrogen and *Azotobacter* on total N P& K content in leaves of mango cv. Amrapali under HDP

Treatment	Nitrogen content in leaf (%)			Phosphorus content in leaf (%)			Potassium content in leaf (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x A ₀	1.219	1.241	1.230	0.089	0.090	0.089	0.88	0.90	0.89
N ₂ x A ₀	1.283	1.312	1.298	0.103	0.100	0.101	0.94	0.97	0.96
N ₃ x A ₀	1.444	1.453	1.449	0.098	0.114	0.106	1.03	1.10	1.06
N ₄ x A ₀	1.480	1.503	1.492	0.113	0.124	0.118	1.13	1.13	1.13
N ₁ x A ₁	1.482	1.271	1.377	0.093	0.100	0.096	0.89	0.92	0.91
N ₂ x A ₁	1.277	1.325	1.301	0.093	0.109	0.101	0.95	1.00	0.97
N ₃ x A ₁	1.401	1.433	1.417	0.118	0.123	0.120	1.10	1.11	1.11
N ₄ x A ₁	1.491	1.520	1.505	0.122	0.134	0.128	1.13	1.15	1.14
SEm_±	0.002	0.0.7	0.010	0.002	0.001	0.001	0.02	0.01	0.01
CD (P=0.05)	0.006	NS	0.027	0.006	NS	0.003	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.14 a: Interaction effect of level of nitrogen and *Azotobacter* on soil fertility status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dSm ⁻¹)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ x A ₀	6.85	6.81	6.83	0.273	0.267	0.270	0.523	0.533	0.528	301.04	304.53	302.78
N ₂ x A ₀	6.91	6.87	6.89	0.287	0.260	0.273	0.537	0.543	0.540	303.41	305.63	304.52
N ₃ x A ₀	7.00	7.06	7.03	0.293	0.283	0.288	0.547	0.550	0.548	305.58	307.34	306.46
N ₄ x A ₀	7.12	7.20	7.16	0.260	0.253	0.257	0.560	0.563	0.562	307.16	308.53	307.85
N ₁ x A ₁	6.85	6.83	6.84	0.270	0.273	0.272	0.527	0.537	0.532	301.74	304.98	303.36
N ₂ x A ₁	6.87	6.83	6.85	0.283	0.256	0.270	0.540	0.547	0.543	303.76	306.87	305.32
N ₃ x A ₁	7.02	7.10	7.06	0.297	0.270	0.283	0.560	0.557	0.558	305.45	307.66	306.56
N ₄ x A ₁	7.17	7.24	7.21	0.260	0.247	0.253	0.570	0.577	0.573	307.70	309.08	308.39
SEm_±	0.07	0.09	0.06	0.004	0.004	0.004	0.008	0.008	0.006	1.62	1.26	1.03
CD (P=0.05)	NS	NS	NS	NS	NS	0.008	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.14 b: Interaction effect of level of nitrogen and *Azotobacter* on soil fertility status and microbial population at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ x A ₀	30.38	33.83	32.10	148.53	151.69	150.11	7.84	7.92	7.88	2.22	2.34	2.28	6.20	6.31	6.25
N ₂ x A ₀	30.58	33.90	32.24	148.57	151.74	150.16	8.32	8.40	8.36	2.61	2.64	2.63	7.35	7.42	7.39
N ₃ x A ₀	30.72	33.97	32.35	148.65	151.78	150.22	8.79	8.88	8.84	2.82	2.84	2.83	8.21	8.26	8.24
N ₄ x A ₀	30.93	34.07	32.50	148.81	151.83	150.32	11.28	11.44	11.36	2.88	2.91	2.90	8.82	8.89	8.85
N ₁ x A ₁	30.42	33.86	32.14	148.62	151.72	150.17	8.29	8.39	8.34	2.32	2.39	2.35	6.58	6.64	6.61
N ₂ x A ₁	30.64	33.96	32.30	148.65	151.77	150.21	8.86	8.93	8.90	2.68	2.72	2.70	7.71	7.77	7.74
N ₃ x A ₁	30.78	34.02	32.40	148.73	151.82	150.28	11.14	11.22	11.18	2.92	2.95	2.94	8.41	8.49	8.45
N ₄ x A ₁	30.99	34.12	32.56	148.88	151.86	150.37	12.91	13.03	12.97	2.96	2.99	2.98	9.13	9.19	9.16
SEm±	0.19	0.12	0.11	1.27	3.30	0.86	0.11	0.12	0.07	0.04	0.03	0.02	0.10	0.10	0.07
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.31	0.28	0.20	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.15a: Interaction effect of level of nitrogen and *Azotobacter* on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dSm ⁻¹)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ x A ₀	7.15	7.19	7.17	0.246	0.197	0.221	0.363	0.377	0.370	133.03	134.53	133.78
N ₂ x A ₀	7.22	7.28	7.25	0.249	0.196	0.223	0.370	0.370	0.370	135.32	135.63	135.48
N ₃ x A ₀	7.33	7.43	7.38	0.260	0.200	0.230	0.377	0.387	0.382	137.13	137.34	137.24
N ₄ x A ₀	7.44	7.47	7.45	0.247	0.193	0.220	0.397	0.407	0.402	139.16	138.53	138.85
N ₁ x A ₁	7.30	7.37	7.33	0.249	0.197	0.223	0.370	0.373	0.372	133.74	134.98	134.36
N ₂ x A ₁	7.30	7.31	7.30	0.250	0.197	0.223	0.380	0.390	0.385	135.76	136.20	135.98
N ₃ x A ₁	7.30	7.34	7.32	0.250	0.203	0.227	0.390	0.397	0.393	137.45	137.66	137.56
N ₄ x A ₁	7.40	7.47	7.44	0.247	0.187	0.217	0.407	0.417	0.412	139.70	139.08	139.39
SEm±	0.06	0.08	0.06	0.003	0.004	0.003	0.006	0.007	0.004	0.99	0.86	0.66
CD (P=0.05)	NS	NS	NS	NS	NS	0.006	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.15 b: Interaction effect of level of nitrogen and *Azotobacter* on soil fertility status and microbial population at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ × A ₀	13.63	14.54	14.08	119.34	120.99	120.17	5.28	5.32	5.30	1.65	1.66	1.66	4.49	4.57	4.53
N ₂ × A ₀	13.72	14.64	14.18	119.38	121.02	120.20	5.37	5.40	5.39	1.99	2.00	1.99	4.87	4.93	4.90
N ₃ × A ₀	14.07	14.86	14.47	119.49	121.08	120.29	5.44	5.52	5.48	2.22	2.24	2.23	5.10	5.16	5.13
N ₄ × A ₀	14.19	15.12	14.66	119.58	121.14	120.36	5.60	5.71	5.66	2.27	2.30	2.28	5.55	5.62	5.58
N ₁ × A ₁	13.68	14.58	14.13	119.37	121.02	120.20	5.46	5.48	5.47	1.71	1.72	1.72	4.65	4.70	4.67
N ₂ × A ₁	13.77	14.70	14.23	119.42	121.07	120.24	5.52	5.68	5.60	2.02	2.04	2.03	5.01	5.07	5.04
N ₃ × A ₁	14.12	14.92	14.52	119.55	121.12	120.34	5.77	5.83	5.80	2.27	2.29	2.28	5.28	5.35	5.31
N ₄ × A ₁	14.24	15.19	14.72	119.64	121.16	120.40	5.91	6.02	5.97	2.31	2.33	2.32	5.73	5.80	5.76
SEm±	0.18	0.17	0.12	1.05	1.25	0.81	0.08	0.07	0.05	0.02	0.01	0.01	0.07	0.07	0.05
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.16 a: Interaction effect of level of nitrogen and *Azotobacter* on soil fertility status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dS/m)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ × A ₀	7.12	7.40	7.26	0.233	0.143	0.188	0.140	0.140	0.140	80.70	81.42	81.06
N ₂ × A ₀	7.17	7.39	7.28	0.237	0.133	0.185	0.143	0.150	0.147	81.32	82.12	81.72
N ₃ × A ₀	7.21	7.45	7.33	0.247	0.140	0.193	0.153	0.160	0.157	82.94	83.64	83.29
N ₄ × A ₀	7.16	7.37	7.27	0.213	0.117	0.165	0.170	0.180	0.175	84.28	84.86	84.57
N ₁ × A ₁	7.13	7.41	7.27	0.246	0.153	0.200	0.147	0.147	0.147	80.98	81.63	81.31
N ₂ × A ₁	7.09	7.33	7.21	0.233	0.153	0.193	0.150	0.160	0.155	81.58	82.38	81.98
N ₃ × A ₁	7.17	7.41	7.29	0.250	0.123	0.186	0.167	0.173	0.170	83.18	84.09	83.63
N ₄ × A ₁	7.09	7.29	7.19	0.223	0.123	0.173	0.187	0.190	0.188	84.59	85.25	84.92
SEm±	0.07	0.12	0.07	0.003	0.002	0.002	0.003	0.002	0.002	1.19	0.30	0.61
CD (P=0.05)	NS	NS	NS	NS	0.006	0.006	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

and microbial population were not affected significantly due to combine application of nitrogen and *Azotobacter* during both the years as well as pooled except electrical conductivity (pooled only), which showed maximum value (0.230 dS/ m) with the treatment combination of $N_3 \times A_0$ i.e. application of nitrogen @ 100 g/tree in the absence of *Azotobacter*.

4.2.8. Interaction effect of nitrogen and *Azotobacter* on soil fertility status at 60-90 cm depth

The data on soil fertility status (pH, EC, Organic carbon, available nitrogen, phosphorus and potassium) and microbial population (*Azotobacter*, bacterial and fungal) at 60-90 cm soil depth presented in Table 4.17a and 4.17b revealed that the interaction effect due to nitrogen and *Azotobacter* did not show any significant improvement towards the soil fertility and microbial population except electrical conductivity (pooled), which varied significantly and obtained maximum value (0.200 dS/ m) with the combined application of nitrogen @ 60g/tree and *Azotobacter* @ 200 g/tree ($N_1 \times A_1$

4.3. Interaction effects of nitrogen and vermicompost

4.3.1. Interaction effect of nitrogen and vermicompost on phenological observations

Perusal of Table 4.17 clearly indicates that the plant height and plant spread (N-S) significantly influenced by interaction of nitrogen and vermicompost, whereas, plant spread (E-W) and canopy volume did not touch the level of significant. The maximum increase (33.52 %) in plant height was noted with combined application of nitrogen @ 120 g/tree and *In-situ* vermicomposting, while, the lowest value (17.25 %) was obtained with the combined application of $N_1 \times V_0$.

The highest increase in plant canopy spread (N-S) i.e. 16.86 % was noted with the combined application of nitrogen @ 120 g/tree (N_4) and in-situ vermicomposting (V_2), however, the lowest value was observed under the treatment combination of nitrogen @ 60 g/tree without application of vermicompost ($N_1 \times V_0$).

4.3.2. Interaction effect of nitrogen and vermicompost on fruiting behaviour

Data recorded on account of fruit set, fruit drop and fruit retention as influenced by interaction effect of different levels of nitrogen and vermicompost during 2014-15, 2015-16 and pooled have been given in Table 4.19.

Pooled over data for two years presented in tables indicated that the highest fruit set (17.60%) was noted with the combined application of nitrogen @ 100 g/tree (N_3) and vermicompost @ 4.0kg per tree, which was statistically at par with combined application of nitrogen @ 100/tree along with in-situ vermicomposting ($N_3 \times V_2$) and significantly superior to rest of the treatment combinations.

Table 4.16 b: Interaction effect of level of nitrogen and *Azotobacter* on soil fertility status and microbial population at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ × A ₀	8.347	8.743	8.545	84.70	85.28	84.99	2.13	2.14	2.14	0.91	0.92	0.91	2.13	2.15	2.14
N ₂ × A ₀	8.461	8.820	8.640	84.73	85.32	85.03	2.13	2.17	2.15	1.07	1.07	1.07	2.18	2.20	2.19
N ₃ × A ₀	8.767	8.940	8.854	84.79	85.36	85.08	2.12	2.15	2.13	1.13	1.14	1.13	2.26	2.34	2.30
N ₄ × A ₀	8.880	9.027	8.954	84.84	85.46	85.15	2.14	2.17	2.16	1.24	1.25	1.24	2.62	2.66	2.64
N ₁ × A ₁	8.374	8.793	8.584	84.72	85.30	85.01	2.02	2.15	2.09	0.94	0.96	0.95	2.12	2.15	2.14
N ₂ × A ₁	8.487	8.867	8.677	84.76	85.36	85.06	2.14	2.17	2.15	1.08	1.08	1.08	2.20	2.23	2.22
N ₃ × A ₁	8.807	8.997	8.902	84.82	85.40	85.11	2.14	2.16	2.15	1.14	1.15	1.15	2.38	2.42	2.40
N ₄ × A ₁	8.907	9.084	8.995	84.87	85.47	85.17	2.15	2.19	2.17	1.26	1.27	1.26	2.62	2.68	2.65
SEm±	0.14	0.10	0.08	0.88	1.00	0.67	0.02	0.01	0.01	0.02	0.02	0.01	0.03	0.03	0.02
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.05	NS	0.03	NS	NS	NS	NS	NS	NS

Table 4.17: Interaction effect of level of nitrogen and vermicompost on vegetative growth of mango cv. Amrapali under HDP

Treatment	Plant Height increased (%)			Plant Spread N-S (%)			Plant Spread E-W (%)			Canopy volume (m ³)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ × V ₀	15.54	18.96	17.25	7.64	9.53	8.59	7.02	8.28	7.65	7.82	8.55	8.18
N ₂ × V ₀	16.65	19.70	18.17	8.52	11.87	10.19	7.94	9.90	8.92	8.95	9.54	9.24
N ₃ × V ₀	19.85	21.66	20.76	10.58	13.43	12.00	10.15	11.79	10.97	9.99	10.46	10.23
N ₄ × V ₀	25.50	26.86	26.18	11.53	14.00	12.76	11.07	12.53	11.80	10.40	13.55	11.97
N ₁ × V ₁	16.48	19.47	17.98	8.62	10.92	9.77	7.99	9.45	8.72	8.46	9.30	8.88
N ₂ × V ₁	17.17	20.20	18.68	9.42	12.98	11.20	8.91	10.94	9.92	9.65	10.62	10.14
N ₃ × V ₁	21.04	23.95	22.49	11.67	14.14	12.90	11.10	12.62	11.86	10.91	11.54	11.22
N ₄ × V ₁	27.55	28.38	27.96	12.76	16.24	14.50	12.01	14.12	13.07	11.62	12.97	12.30
N ₁ × V ₂	19.98	21.32	20.65	9.87	12.35	11.11	9.14	10.74	9.94	10.49	11.45	10.97
N ₂ × V ₂	21.55	23.48	22.51	11.06	14.58	12.82	10.45	12.51	11.48	12.14	13.24	12.69
N ₃ × V ₂	24.58	25.39	24.98	12.95	16.09	14.52	12.42	14.25	13.34	12.40	15.06	13.73
N ₄ × V ₂	32.88	34.17	33.52	15.34	18.38	16.86	14.39	16.38	15.38	13.65	15.89	14.77
SEm±	0.62	0.82	0.51	0.32	0.38	0.25	0.37	0.50	0.31	0.38	0.53	0.33
CD (P=0.05)	NS	NS	1.44	NS	NS	0.70	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.18: Interaction effect of level of nitrogen and vermicompost on fruiting behaviour of mango cv. Amrapali under HDP

Treatment	Fruit set (%)			Fruit drop (%)			Fruit retention (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	pooled
N ₁ x V ₀	8.55	8.57	8.56	95.09	90.35	92.72	4.92	9.64	7.28
N ₂ x V ₀	11.96	11.99	11.98	93.22	89.95	91.59	6.78	10.05	8.41
N ₃ x V ₀	16.16	16.18	16.17	91.34	89.37	90.35	8.66	10.80	9.73
N ₄ x V ₀	16.02	16.04	16.03	92.47	87.41	89.94	7.53	12.59	10.06
N ₁ x V ₁	9.54	9.57	9.55	94.70	91.92	93.31	5.30	8.08	6.69
N ₂ x V ₁	13.15	13.17	13.16	92.91	90.35	91.63	7.09	9.65	8.37
N ₃ x V ₁	17.59	17.61	17.60	90.94	89.67	90.30	7.82	12.35	10.08
N ₄ x V ₁	15.52	15.55	15.54	92.18	87.65	89.92	9.06	10.33	9.70
N ₁ x V ₂	9.38	9.40	9.39	94.86	92.29	93.58	5.14	7.71	6.42
N ₂ x V ₂	13.04	13.07	13.05	92.84	91.14	91.99	7.16	8.86	8.01
N ₃ x V ₂	17.38	17.43	17.41	90.88	89.06	89.97	9.12	10.94	10.03
N ₄ x V ₂	15.21	15.23	15.22	92.22	87.86	90.04	7.78	12.14	9.96
SEm_±	0.33	0.37	0.35	1.96	1.89	1.36	0.38	0.37	0.27
CD (P=0.05)	0.95	NS	0.70	NS	NS	NS	NS	NS	0.46

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=Vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

The minimum fruit set (8.56 %) was observed under $N_1 \times V_0$.

Pooled data revealed that the highest value of fruit retention was counted with the combined application of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg/tree ($N_3 \times V_1$), which was statistically at par with $N_4 \times V_2$, $N_3 \times V_2$, $N_3 \times V_1$, $N_4 \times V_0$ and $N_3 \times V_0$.

None of the interaction was found to be significant for the fruit drop during both the years as well as pooled for two years.

4.3.3. Interaction effect of nitrogen and vermicompost on physical parameters of fruit and fruit yield

Data regarding physical parameters of fruit (*i.e.* fruit weight, fruit length, fruit width, pulp weight, pulp percent, peel weight, stone weight, pulp stone ratio and pulp peel ratio) and yield as influenced by interaction effect of different levels of nitrogen and vermicompost have been given in Table 4.19a, 4.19b and 4.19c.

It is evident of from the tables that the fruit weight was significantly influenced by interactive use of different levels of nitrogen and vermicompost. The plant getting nitrogen @ 120 g/tree in the along with in-situ vermicomposting ($N_4 \times V_2$) in integration produced highest fruit weight (202.23 g), which was significantly higher over the rest of treatment combination of nitrogen and vermicompost (pooled over two years).

Pooled analysis indicated that the largest fruit length (10.66 cm) was also recorded under $N_4 \times V_2$, which was found statistically similar with $N_4 \times V_1$ and $N_2 \times V_0$ that resulted fruit length 10.25 cm and 10.47 cm respectively. The smallest fruit length (9.49 cm) was found with $N_3 \times V_1$.

According to pooled data the maximum pulp weight (129.24 g/fruit) was noted with the combined application of nitrogen @ 120 g/tree and in-situ vermicomposting ($N_4 \times V_0$), which was statistically at par with $N_4 \times V_1$ (122.47 g/fruit). The minimum pulp weight (93.59 g/fruit) was noted with combined application of nitrogen 100g/tree and vermicompost 4.0 kg/tree (*i.e.* $N_3 \times V_1$)

The perusal of pooled data revealed that the highest peel weight (33.07 g/fruit) was found with combined application of nitrogen @120 g/tree and vermicomposting @ 4.0 kg/tree ($N_4 \times V_1$), which was found statistically at par with application of nitrogen @120g + in-situ vermicomposting ($N_4 \times V_2$) and nitrogen @ 80 g/tree in the absence of vermicompost ($N_2 \times V_0$), that results peel weight 30.38g and 30.60 g/fruit, respectively.

The lowest stone weight was significantly noted with the combined application of nitrogen @ 100 g/tree + vermicomposting @ 4.0 kg/tree ($N_4 \times V_1$), which was showed

Table 4.19a: Interaction effect of level of nitrogen and vermicompost on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Fruit weight (g)			Fruit length (cm)			Fruit width (cm)			Pulp weight (g/fruit)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀	166.18	156.42	161.30	10.34	9.33	9.84	5.60	6.12	5.86	96.97	97.69	97.33
N ₂ x V ₀	190.25	176.85	183.55	11.04	9.90	10.47	6.02	5.90	5.96	117.77	117.30	117.53
N ₃ x V ₀	158.85	143.83	151.34	10.27	9.13	9.70	6.33	6.11	6.22	100.39	101.77	101.08
N ₄ x V ₀	184.52	177.42	180.97	10.74	9.55	10.14	6.39	6.44	6.41	114.97	118.54	116.76
N ₁ x V ₁	166.60	161.40	164.00	10.35	9.20	9.78	6.07	6.25	6.16	99.75	106.37	103.06
N ₂ x V ₁	180.85	173.93	177.39	10.48	9.34	9.91	6.53	6.37	6.45	111.80	115.19	113.49
N ₃ x V ₁	144.82	135.35	140.08	10.07	8.90	9.49	6.86	6.00	6.43	92.53	94.66	93.59
N ₄ x V ₁	192.45	184.83	188.64	10.82	9.68	10.25	6.93	6.53	6.73	120.02	124.92	122.47
N ₁ x V ₂	160.88	151.95	156.42	10.24	9.11	9.67	6.17	6.23	6.20	95.66	98.09	96.88
N ₂ x V ₂	148.77	143.58	146.18	10.20	9.05	9.62	6.64	6.27	6.46	92.00	96.93	94.47
N ₃ x V ₂	150.43	146.02	148.23	10.17	9.02	9.59	6.98	6.08	6.53	94.38	97.30	95.84
N ₄ x V ₂	206.77	197.68	202.23	11.25	10.07	10.66	7.04	6.60	6.82	128.37	130.12	129.24
SEm±	0.38	6.10	3.06	0.71	0.59	0.16	0.16	0.24	0.40	3.78	5.77	3.45
CD (P=0.05)	1.08	17.38	8.59	NS	NS	0.46	NS	NS	NS	10.77	16.43	9.69

Table 4.19b: Interaction effect of level of nitrogen and vermicompost on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp percent			Peel weight (g/fruit)			Stone weight (g/fruit)			Pulp stone ratio		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ x V ₀	58.35	62.46	60.41	29.21	30.73	29.97	27.50	28.00	27.75	3.53	3.49	3.51
N ₂ x V ₀	62.00	66.33	64.17	30.52	30.68	30.60	29.13	28.87	29.00	4.04	4.06	4.05
N ₃ x V ₀	63.17	70.69	66.93	23.02	23.77	23.40	22.94	23.39	23.17	4.37	4.36	4.36
N ₄ x V ₀	62.31	66.81	64.56	28.67	29.62	29.14	28.55	29.26	28.91	4.05	4.05	4.05
N ₁ x V ₁	60.79	65.86	63.33	26.30	27.48	26.89	26.35	27.55	26.95	3.85	3.86	3.85
N ₂ x V ₁	61.82	66.23	64.03	27.84	28.90	28.37	28.71	29.85	29.28	3.90	3.87	3.89
N ₃ x V ₁	63.89	69.95	66.92	20.10	20.85	20.47	19.69	19.84	19.77	4.70	4.77	4.74
N ₄ x V ₁	62.34	66.67	64.51	29.98	30.79	30.38	29.95	30.80	30.37	4.01	4.00	4.00
N ₁ x V ₂	59.41	64.51	61.96	26.23	26.80	26.51	26.48	27.07	26.78	3.61	3.62	3.61
N ₂ x V ₂	61.85	67.51	64.68	22.22	23.45	22.83	22.04	23.21	22.62	4.18	4.18	4.18
N ₃ x V ₂	62.74	68.19	65.46	22.02	23.09	22.56	21.54	22.29	21.91	4.38	4.37	4.37
N ₄ x V ₂	62.09	65.82	63.95	32.76	33.37	33.07	33.22	34.19	33.70	3.87	3.81	3.84
SEm±	1.70	2.27	1.42	1.94	0.35	0.99	1.18	0.96	0.76	0.17	0.16	0.12
CD (P=0.05)	NS	NS	NS	NS	1.00	2.77	3.37	2.74	2.14	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V= vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

statistically similar with the application of nitrogen @ 100 g/tree + *in-situ* vermicomposting ($N_4 \times V_2$) and most superiority with the remaining interactions of nitrogen and vermicomposting. The highest stone weight was obtained with the treatment combination of $N_1 \times V_2$.

The scrutiny of pooled data exhibit that the interaction effect of levels of nitrogen and vermicompost caused significant variation on pulp: peel ratio. The highest value of pulp: peel ratio (4.57) was noted with combined application of nitrogen @ 100g/tree along with 4.0 kg of vermicompost per tree, which was significantly higher over the rest of treatment combination.

The highest number of fruits/plant (82.35) was produced with the application of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg per tree ($N_3 \times V_1$), which was statistically at par with the application of nitrogen @ 100 g/tree + *in-situ* vermicomposting ($N_3 \times V_2$). The lowest number of fruits per plant (42.48) was observed with the treatment combination of $N_1 \times V_0$ (Pooled data).

However the interaction effect of nitrogen and vermicompost did not cause any significant variation in fruit width, pulp percent, pulp: stone and yield (kg/ha as well as t/ha) (pooled data over two years).

4.3.4. Interaction effect of nitrogen and vermicompost on biochemical and antioxidant compounds of fruit

The interaction due to nitrogen and vermicompost showed significant improvement in titratable acidity, TSS/acidity ratio and ascorbic acid content except TSS, total sugars and total carotenoids during 2014-15, 2015-16 and pooled over two years (Table 4.20a and 4.20b).

Significantly lowest titratable acidity (0.138%) was noted with the application of nitrogen @ 100 g/tree along with vermicomposting @ 4.0 kg/tree ($N_3 \times V_1$). The highest fruit acidity (0.249%) was observed with the combined application of $N_1 \times V_0$ (Pooled)

The plant getting the nitrogen @ 100g/tree along with vermicomposting @ 4.0 kg/tree ($N_3 \times V_1$) also produced significantly the highest TSS/acidity ratio (170.62) as compare to other treatment combination, while lowest TSS/acidity ratio (70.31) was recorded in plant grown under the treatment combination of 60g of nitrogen in the absence of vermicomposting (Pooled over two years).

The highest ascorbic acid of fruit (39.62 mg/100g pulp) was also noted with treatment combination of $N_3 \times V_1$. The differences between $N_3 \times V_1$ and $N_3 \times V_2$ were statistically not significant.

Table 4.19c: Interaction effect of level of nitrogen and vermicompost on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp peel ratio			Yield (fruit/tree)			Yield (kg/tree)			Yield (t/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀	3.33	3.18	3.25	36.45	48.50	42.48	6.22	7.59	6.90	9.30	14.17	11.74
N ₂ x V ₀	3.86	3.83	3.85	39.88	51.50	45.69	7.37	9.09	8.23	11.94	16.76	14.35
N ₃ x V ₀	4.36	4.28	4.32	55.43	81.00	68.22	10.42	11.67	11.04	15.53	20.29	17.91
N ₄ x V ₀	4.01	4.00	4.01	53.56	62.50	58.03	9.88	11.15	10.51	15.47	20.43	17.95
N ₁ x V ₁	3.84	3.86	3.85	42.54	55.00	48.77	7.10	7.90	7.50	11.22	16.05	13.64
N ₂ x V ₁	4.02	3.99	4.00	45.75	59.50	52.63	8.28	10.38	9.33	12.98	17.82	15.40
N ₃ x V ₁	4.60	4.54	4.57	77.21	87.50	82.35	11.19	11.86	11.52	16.94	21.57	19.26
N ₄ x V ₁	4.00	4.00	4.00	53.52	65.50	59.51	10.33	12.11	11.22	16.00	20.96	18.48
N ₁ x V ₂	3.64	3.66	3.65	45.41	53.50	49.45	7.33	8.08	7.70	11.02	15.76	13.39
N ₂ x V ₂	4.14	4.13	4.14	55.50	70.00	62.75	8.32	10.07	9.20	12.77	17.78	15.27
N ₃ x V ₂	4.29	4.21	4.25	72.95	83.83	78.39	10.97	11.65	11.31	16.68	21.49	19.08
N ₄ x V ₂	3.93	3.90	3.91	47.39	55.50	51.44	9.83	10.99	10.41	16.70	20.54	18.62
SEm±	0.19	0.12	0.11	4.67	0.92	2.38	0.46	0.21	0.25	0.65	0.55	0.43
CD (P=0.05)	NS	NS	0.31	NS	2.62	6.69	NS	0.59	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.20 a: Interaction effect of level of nitrogen and vermicompost on biochemical and antioxidant compounds of mango fruit cvAmrapali under HDP

Treatment	TSS (^o Brix)			Titratable Acidity (%)			TSS/Acid Ratio		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀	20.55	20.56	20.56	0.303	0.286	0.294	68.08	72.53	70.31
N ₂ x V ₀	21.59	21.61	21.60	0.271	0.249	0.260	80.01	86.93	83.47
N ₃ x V ₀	22.93	23.00	22.96	0.212	0.204	0.208	109.54	114.18	111.86
N ₄ x V ₀	21.22	21.28	21.25	0.239	0.229	0.234	89.22	93.94	91.58
N ₁ x V ₁	20.98	20.96	20.97	0.214	0.216	0.215	98.03	95.52	96.78
N ₂ x V ₁	21.93	21.97	21.95	0.177	0.169	0.173	125.00	130.81	127.91
N ₃ x V ₁	23.45	23.51	23.48	0.143	0.134	0.138	165.13	176.10	170.62
N ₄ x V ₁	21.53	21.58	21.55	0.164	0.159	0.161	132.05	135.82	133.93
N ₁ x V ₂	20.92	20.94	20.93	0.220	0.219	0.219	95.54	96.02	95.78
N ₂ x V ₂	22.05	22.09	22.07	0.191	0.170	0.180	116.52	130.45	123.48
N ₃ x V ₂	23.42	23.48	23.45	0.150	0.144	0.147	156.14	163.56	159.85
N ₄ x V ₂	21.47	21.50	21.49	0.193	0.185	0.189	111.42	116.43	113.93
SEm±	0.31	0.30	0.21	0.003	0.002	0.002	2.06	1.07	1.16
CD (P=0.05)	NS	1.31	NS	0.010	0.007	0.006	5.87	3.06	3.26

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table4.20b: Interaction effect of level of nitrogen and vermicompost on biochemical and antioxidant compounds of mango fruit cv. Amrapali under HDP

Treatment	Total sugars (%)			Total carotenoids (mg/100g pulp)			Ascorbic acid content (mg/100g pulp)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	pooled
N ₁ x V ₀	15.56	15.57	15.56	15.85	16.81	16.33	27.75	30.19	28.97
N ₂ x V ₀	16.81	16.84	16.82	16.97	17.65	17.31	33.77	33.96	33.87
N ₃ x V ₀	17.76	17.81	17.79	18.07	18.28	18.17	36.89	37.17	37.03
N ₄ x V ₀	17.30	17.34	17.32	17.49	17.50	17.49	36.92	37.01	36.96
N ₁ x V ₁	15.90	15.90	15.90	16.27	17.15	16.71	30.09	32.75	31.42
N ₂ x V ₁	17.11	17.15	17.13	17.31	17.87	17.59	34.26	34.40	34.33
N ₃ x V ₁	18.18	18.25	18.22	18.65	18.52	18.58	39.43	39.82	39.62
N ₄ x V ₁	17.55	17.60	17.58	17.71	17.67	17.69	37.16	37.25	37.20
N ₁ x V ₂	15.92	15.90	15.91	16.30	17.15	16.72	31.21	32.59	31.90
N ₂ x V ₂	17.09	17.53	17.31	17.33	17.85	17.59	34.20	34.23	34.21
N ₃ x V ₂	18.18	18.21	18.20	18.71	18.52	18.61	38.64	38.88	38.76
N ₄ x V ₂	17.42	17.53	17.47	17.69	17.69	17.69	37.03	37.13	37.08
SEm_±	0.19	0.15	0.12	0.21	0.13	0.12	0.52	0.46	0.35
CD (P=0.05)	NS	NS	NS	NS	NS	NS	1.48	1.31	0.98

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

4.3.5. Interaction effect of nitrogen and vermicompost on total nitrogen, phosphorus and potassium content in leaves at harvest

Data recorded on account of total nitrogen, phosphorus and potassium content in leaves as influenced by interaction effect of different levels of nitrogen and vermicompost have been presented in Table 4.21.

The highest total nitrogen content (1.521 %) in leaves was noted with the application of nitrogen @ 120 g/tree along with in-situ vermicomposting ($N_4 \times V_2$), which was statistically similar with application of nitrogen @ 120 g/tree + vermicompost @ 4.0 kg/ha (1.508 %). The lowest value (1.355%) was observed in $N_1 \times V_0$ (Pooled).

The pooled data summarized in Table 4.21 revealed that the highest leaf phosphorus (0.143 %) was also noted in $N_4 \times V_2$, which was significantly superior over all of the treatment combinations. However, the lowest value (0.083%) was observed in $N_1 \times V_0$.

A cursory glance over the pooled data presented in table revealed that the highest total potassium content (1.16 %) was found in $N_4 \times V_2$, which was statistically similar to the treatment combination of $N_3 \times V_2$ and $N_4 \times V_1$.

4.3.6. Interaction effect of nitrogen and vermicompost on soil fertility status and microbial population at 0-30 cm depth after fruit harvest

Table 4.22a and 4.22b indicates that the interaction effect due to nitrogen and vermicompost did not show any significant improvement towards EC, organic carbon, available nitrogen, P_2O_5 , K_2O and bacterial population at 0-30 cm soil depth after fruit harvest except pH, fungal and *Azotobacter* population. Maximum pH values (7.26) and fungal (9.6×10^4 /g soil) and *Azotobacter* population (12.9×10^4 /g soil) were observed under the treatment combination of nitrogen @ 120g/tree along with in-situ vermicomposting ($N_4 \times V_2$), which were significantly superior over all the treatment combination (pooled data over two years).

4.3.7. Effects of nitrogen and vermicompost on soil fertility status and microbial population at 30-60 cm depth after fruit harvest

Data regarding soil fertility status *i.e.* pH, EC, organic carbon, available N, P_2O_5 , K_2O and microbial population *i.e.* *Azotobacter*, bacterial and fungal count population at 30-60 cm depth after fruit harvest as influenced by interactive use of nitrogen and vermicompost have been presented in Table 4.23a and 4.23b.

Pooled over data for two years presented in table indicated that none of the soil fertility status and microbial population varied significantly due to interactive use of N x V except electrical conductivity and organic carbon, which were statistically significant.

Table 4.21: Interaction effect of level of nitrogen and vermicompost on NPK content in mango leaf at harvest stage cv. Amrapali under HDP

Treatment	Total nitrogen content in leaf (%)			Total phosphorus content in leaf (%)			Total potassium content in leaf (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	pooled
N ₁ x V ₀	1.518	1.192	1.355	0.081	0.085	0.083	0.87	0.90	0.89
N ₂ x V ₀	1.240	1.300	1.270	0.098	0.095	0.096	0.92	0.94	0.93
N ₃ x V ₀	1.371	1.400	1.385	0.102	0.115	0.108	0.98	1.07	1.02
N ₄ x V ₀	1.468	1.465	1.467	0.095	0.105	0.100	1.11	1.12	1.11
N ₁ x V ₁	1.233	1.267	1.250	0.092	0.095	0.093	0.89	0.91	0.90
N ₂ x V ₁	1.230	1.266	1.248	0.100	0.105	0.103	0.94	0.98	0.96
N ₃ x V ₁	1.435	1.445	1.440	0.107	0.109	0.108	1.08	1.11	1.10
N ₄ x V ₁	1.495	1.520	1.508	0.123	0.131	0.127	1.14	1.15	1.14
N ₁ x V ₂	1.300	1.310	1.305	0.099	0.105	0.102	0.91	0.93	0.92
N ₂ x V ₂	1.370	1.390	1.380	0.097	0.114	0.105	0.97	1.05	1.01
N ₃ x V ₂	1.461	1.485	1.473	0.115	0.131	0.123	1.14	1.14	1.14
N ₄ x V ₂	1.493	1.550	1.521	0.135	0.150	0.143	1.15	1.16	1.16
SEm±	0.002	0.020	0.012	0.002	0.001	0.001	0.02	0.01	0.01
CD (P=0.05)	0.007	NS	0.033	0.007	0.003	0.004	NS	0.03	0.04

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.22a: Interaction effect of level of nitrogen and vermicompost on soil fertility status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dSm ⁻¹)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ x V ₀	6.65	6.67	6.66	0.270	0.270	0.270	0.500	0.500	0.500	299.5	303.4	301.5
N ₂ x V ₀	6.87	6.84	6.85	0.270	0.255	0.263	0.500	0.505	0.503	301.4	303.9	302.7
N ₃ x V ₀	6.98	7.05	7.01	0.280	0.290	0.285	0.505	0.510	0.508	304.5	306.0	305.2
N ₄ x V ₀	7.15	7.22	7.18	0.245	0.235	0.240	0.510	0.515	0.513	305.5	307.3	306.4
N ₁ x V ₁	6.84	6.78	6.81	0.300	0.265	0.283	0.520	0.530	0.525	301.2	304.3	302.8
N ₂ x V ₁	6.85	6.78	6.81	0.295	0.250	0.273	0.525	0.540	0.533	303.1	306.7	304.9
N ₃ x V ₁	6.97	7.05	7.01	0.310	0.255	0.283	0.550	0.550	0.550	304.9	307.1	306.0
N ₄ x V ₁	7.06	7.16	7.11	0.270	0.250	0.260	0.560	0.570	0.565	306.8	308.5	307.7
N ₁ x V ₂	7.06	7.02	7.04	0.245	0.275	0.260	0.555	0.575	0.565	303.4	306.6	305.0
N ₂ x V ₂	6.96	6.94	6.95	0.290	0.269	0.280	0.590	0.590	0.590	306.3	308.1	307.2
N ₃ x V ₂	7.10	7.15	7.11	0.295	0.285	0.290	0.605	0.600	0.603	307.1	309.3	308.2
N ₄ x V ₂	7.23	7.29	7.26	0.265	0.265	0.265	0.625	0.625	0.625	310.0	310.6	310.3
SEm±	0.09	0.2	0.07	0.005	0.002	0.005	0.009	0.010	0.007	1.98	1.54	0.510
CD (P=0.05)	NS	NS	0.14	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.22b: Interaction effect of level of nitrogen and vermicompost on soil fertility status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			Azotobacter population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁴ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀	30.286	33.730	32.008	148.3	151.6	149.9	7.7	7.8	7.8	2.1	2.3	2.2	5.7	5.8	5.7
N ₂ x V ₀	30.435	33.810	32.123	148.3	151.7	150.0	8.2	8.3	8.2	2.5	2.6	2.5	6.8	6.9	6.8
N ₃ x V ₀	30.585	33.880	32.233	148.4	151.7	150.0	8.7	8.8	8.7	2.8	2.8	2.8	7.9	7.9	7.9
N ₄ x V ₀	30.800	33.990	32.395	148.5	151.8	150.1	11.3	11.4	11.3	2.8	2.8	2.8	8.2	8.3	8.3
N ₁ x V ₁	30.395	33.850	32.123	148.7	151.7	150.2	8.0	8.2	8.1	2.3	2.4	2.3	6.4	6.4	6.4
N ₂ x V ₁	30.605	33.920	32.263	148.7	151.7	150.2	8.6	8.7	8.6	2.7	2.7	2.7	7.6	7.6	7.6
N ₃ x V ₁	30.750	33.985	32.368	148.8	151.8	150.3	10.0	10.1	10.0	2.9	2.9	2.9	8.3	8.3	8.3
N ₄ x V ₁	30.945	34.110	32.528	148.9	151.8	150.4	12.2	12.4	12.3	2.9	3.0	2.9	9.1	9.2	9.1
N ₁ x V ₂	30.510	33.955	32.233	148.8	151.8	150.3	8.4	8.5	8.5	2.4	2.4	2.4	7.2	7.2	7.2
N ₂ x V ₂	30.785	34.070	32.428	148.8	151.8	150.3	9.0	9.1	9.0	2.8	2.8	2.8	8.2	8.3	8.3
N ₃ x V ₂	30.925	34.115	32.520	148.9	151.9	150.4	11.3	11.3	11.3	3.0	3.0	3.0	8.8	8.9	8.8
N ₄ x V ₂	31.145	34.195	32.670	149.1	151.9	150.5	12.8	12.9	12.9	3.1	3.1	3.1	9.6	9.7	9.6
SEm±	0.23	0.15	0.14	1.56	4.04	1.05	0.13	0.12	0.09	0.05	0.04	0.03	0.12	0.12	0.09
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.37	0.34	0.25	NS	NS	NS	NS	NS	0.24

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= Azotobacter (A₀= Nil, A₁=200g/plant)

Table 4.23a: Interaction effect of level of nitrogen and vermicompost on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dSm ⁻¹)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ x V ₀	7.22	7.14	7.18	0.258	0.185	0.222	0.335	0.345	0.340	131.5	133.4	132.5
N ₂ x V ₀	7.19	7.20	7.20	0.244	0.185	0.215	0.340	0.345	0.343	133.4	133.9	133.7
N ₃ x V ₀	7.42	7.48	7.45	0.255	0.205	0.230	0.350	0.360	0.355	135.8	136.0	135.9
N ₄ x V ₀	7.39	7.46	7.42	0.250	0.185	0.218	0.350	0.360	0.355	137.5	137.3	137.4
N ₁ x V ₁	7.25	7.49	7.37	0.250	0.200	0.225	0.370	0.375	0.373	133.2	134.3	133.8
N ₂ x V ₁	7.26	7.34	7.30	0.245	0.209	0.227	0.380	0.385	0.383	135.1	135.7	135.4
N ₃ x V ₁	7.26	7.32	7.29	0.255	0.195	0.225	0.390	0.400	0.395	136.9	137.1	137.0
N ₄ x V ₁	7.51	7.44	7.48	0.240	0.190	0.215	0.415	0.420	0.418	138.8	138.5	138.7
N ₁ x V ₂	7.20	7.20	7.20	0.235	0.205	0.220	0.395	0.405	0.400	135.4	136.6	136.0
N ₂ x V ₂	7.33	7.34	7.33	0.260	0.195	0.228	0.405	0.410	0.408	138.2	138.1	138.1
N ₃ x V ₂	7.27	7.37	7.32	0.255	0.205	0.230	0.410	0.415	0.413	139.1	139.3	139.2
N ₄ x V ₂	7.36	7.50	7.43	0.250	0.195	0.223	0.440	0.455	0.448	142.0	140.6	141.3
SEm±	0.03	0.10	0.06	0.004	0.005	0.003	0.007	0.008	0.005	1.22	1.06	0.81
CD (P=0.05)	NS	NS	NS	0.011	NS	0.009	NS	NS	0.015	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.23b: Interaction effect of level of nitrogen and vermicompost on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			Azotobacter population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁴ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀	13.56	14.45	14.00	119.25	120.94	120.09	5.28	5.32	5.30	1.58	1.59	1.58	4.2	4.3	4.3
N ₂ x V ₀	13.63	14.54	14.08	119.29	120.96	120.13	5.36	5.39	5.37	1.88	1.89	1.88	4.6	4.6	4.6
N ₃ x V ₀	14.00	14.74	14.37	119.40	121.04	120.22	5.45	5.51	5.48	2.16	2.18	2.17	4.8	4.9	4.9
N ₄ x V ₀	14.11	15.01	14.56	119.46	121.07	120.26	5.53	5.65	5.59	2.21	2.23	2.22	5.2	5.3	5.2
N ₁ x V ₁	13.64	14.55	14.09	119.37	121.01	120.19	5.34	5.36	5.35	1.66	1.67	1.67	4.6	4.7	4.7
N ₂ x V ₁	13.75	14.68	14.21	119.40	121.05	120.22	5.47	5.50	5.48	2.02	2.04	2.03	5.0	5.0	5.0
N ₃ x V ₁	14.09	14.89	14.49	119.55	121.10	120.32	5.56	5.64	5.60	2.25	2.27	2.26	5.2	5.3	5.2
N ₄ x V ₁	14.21	15.15	14.68	119.63	121.15	120.39	5.72	5.86	5.79	2.28	2.30	2.29	5.7	5.8	5.7
N ₁ x V ₂	13.77	14.69	14.23	119.45	121.09	120.27	5.49	5.52	5.50	1.80	1.82	1.81	4.9	4.9	4.9
N ₂ x V ₂	13.86	14.80	14.33	119.50	121.13	120.32	5.51	5.74	5.62	2.11	2.12	2.11	5.3	5.3	5.3
N ₃ x V ₂	14.21	15.04	14.63	119.63	121.17	120.40	5.82	5.89	5.85	2.32	2.34	2.33	5.5	5.6	5.6
N ₄ x V ₂	14.34	15.31	14.83	119.74	121.23	120.48	6.03	6.10	6.07	2.39	2.41	2.40	6.1	6.1	6.1
SEm±	0.22	0.20	0.15	1.29	1.53	1.00	0.10	0.08	0.06	0.02	0.01	0.01	0.09	0.09	0.06
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= Azotobacter (A₀= Nil, A₁=200g/plant)

Maximum value of electrical conductivity (0.230 dS/m) was noted with the application of nitrogen @ 100 g/tree along with In-situ vermicomposting ($N_3 \times V_2$), which showed equality with all the other treatment combination except $N_2 \times V_0$, $N_4 \times V_0$, $N_4 \times V_1$ and $N_1 \times V_1$. However, plant getting 120 g of nitrogen per tree in the presence of In-situ vermicomposting ($N_3 \times V_2$) analysed the highest soil organic carbon (0.448 %), which was statistically superior to rest of the treatment combinations.

4.3.8. Interaction effect of nitrogen and vermicompost on soil fertility status and microbial population at 60-90 cm depth after fruit harvest

The data concerning to soil fertility status *i.e.* pH, EC, organic carbon, available N, P_2O_5 , K_2O and microbial population *i.e.* *Azotobacter*, bacterial and fungal count population at soil depth of 60-90 cm after fruit harvest as influenced by interaction effect of different levels of nitrogen and vermicompost during 2014-15, 2015-16 and pooled have been presented in Table 4.24a and 4.24b.

The pooled data in respect of soil electrical conductivity at the depth of 60-90cm varied significantly due to combined application of nitrogen and vermicomposting. The highest value (0.207 dS/ m) was noted with the treatment combination of $N_1 \times V_0$, however, the lowest value (0.160 dS/ m) was observed with the combined application of $N_4 \times V_2$ (*i.e.* nitrogen @ 120 g/tree + In-situ vermicomposting).

On the basis of pooled data, the highest soil organic carbon (0.220 %) was found under nitrogen @120 g/tree + In - situ vermicomposting ($N_4 \times V_2$), which was statistically superior over rest combinations of nitrogen and vermicomposting.

The perusal of pooled data in table revealed that the highest fungal count (2.75×10^4 /g soil) was noted with the application of nitrogen @ 120g/tree along with In-situ vermicomposting, which was significantly higher over the rest of treatment combination. The lowest fungal count (2.12×10^4 /g soil) was observed with the combine application of $N_1 \times V_0$.

Perusal of Table 4.24a and 4.24b clearly indicated that the interaction effect due to nitrogen and vermicomposting did not touch the level of significant regarding pH, available N, P_2O_5 , K_2O and *Azotobacter* and bacterial count population at 60-90 cm soil depth after fruit harvest.

4.4. Interaction effects of vermicompost and *Azotobacter*

4.4.1. Interaction effect of vermicompost and *Azotobacter* on phenological observations

A cursory glance over the data presented in Table 4.25, clearly shows that the combined use of vermicomposting and *Azotobacter* failed to touch the level of significance

Table 4.24a: Interaction effect of level of nitrogen and vermicompost on soil fertility status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dSm ⁻¹)			Organic carbon(%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ x V ₀	7.11	7.38	7.24	0.254	0.160	0.207	0.130	0.130	0.130	80.3	80.8	80.5
N ₂ x V ₀	7.07	7.32	7.19	0.255	0.120	0.188	0.130	0.135	0.133	80.7	81.5	81.1
N ₃ x V ₀	7.18	7.42	7.30	0.235	0.144	0.190	0.140	0.140	0.140	82.3	82.8	82.5
N ₄ x V ₀	7.12	7.29	7.21	0.220	0.125	0.173	0.145	0.150	0.148	83.4	83.8	83.6
N ₁ x V ₁	7.25	7.51	7.38	0.219	0.150	0.185	0.140	0.140	0.140	80.9	81.5	81.2
N ₂ x V ₁	7.18	7.40	7.29	0.235	0.155	0.195	0.140	0.150	0.145	81.4	82.1	81.7
N ₃ x V ₁	7.18	7.42	7.30	0.255	0.110	0.183	0.155	0.165	0.160	82.9	83.7	83.3
N ₄ x V ₁	7.07	7.33	7.20	0.220	0.130	0.175	0.175	0.180	0.178	84.1	84.7	84.4
N ₁ x V ₂	7.01	7.34	7.18	0.245	0.135	0.190	0.160	0.160	0.160	81.4	82.3	81.9
N ₂ x V ₂	7.13	7.37	7.25	0.215	0.155	0.185	0.170	0.180	0.175	82.2	83.2	82.7
N ₃ x V ₂	7.21	7.46	7.33	0.255	0.140	0.198	0.185	0.195	0.190	84.0	85.1	84.6
N ₄ x V ₂	7.18	7.39	7.28	0.215	0.105	0.160	0.215	0.225	0.220	85.8	86.6	86.2
SEm±	0.09	0.15	0.09	0.004	0.003	0.002	0.003	0.003	0.002	1.46	0.37	0.75
CD (P=0.05)	NS	NS	NS	NS	0.008	0.007	0.009	0.008	0.006	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.24b: Interaction effect of level of nitrogen and vermicompost on soil fertility status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			Azotobacter population (× 10 ⁴ /g soil)			Bacterialpopulation (× 10 ⁶ /g soil)			Fungalpopulation (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀	8.27	8.67	8.47	84.66	85.22	84.94	2.12	2.15	2.13	0.87	0.88	0.88	2.10	2.14	2.12
N ₂ x V ₀	8.38	8.74	8.56	84.69	85.26	84.97	2.14	2.16	2.15	1.04	1.04	1.04	2.20	2.21	2.20
N ₃ x V ₀	8.71	8.85	8.78	84.74	85.29	85.02	2.15	2.16	2.15	1.09	1.10	1.10	2.25	2.32	2.29
N ₄ x V ₀	8.84	8.93	8.88	84.79	85.34	85.06	2.15	2.19	2.17	1.21	1.22	1.21	2.56	2.59	2.57
N ₁ x V ₁	8.36	8.76	8.56	84.71	85.29	85.00	2.12	2.14	2.13	0.93	0.93	0.93	2.12	2.16	2.14
N ₂ x V ₁	8.47	8.85	8.66	84.74	85.34	85.04	2.14	2.17	2.15	1.07	1.08	1.08	2.17	2.20	2.18
N ₃ x V ₁	8.79	8.96	8.87	84.80	85.40	85.10	2.12	2.14	2.13	1.13	1.14	1.14	2.27	2.31	2.29
N ₄ x V ₁	8.87	9.06	8.96	84.84	85.50	85.17	2.14	2.18	2.16	1.24	1.26	1.25	2.62	2.67	2.64
N ₁ x V ₂	8.46	8.88	8.67	84.76	85.36	85.06	1.98	2.16	2.07	0.97	1.00	0.99	2.15	2.16	2.16
N ₂ x V ₂	8.58	8.95	8.76	84.81	85.43	85.12	2.13	2.17	2.15	1.11	1.11	1.11	2.21	2.25	2.23
N ₃ x V ₂	8.87	9.10	8.98	84.89	85.47	85.18	2.12	2.16	2.14	1.18	1.19	1.19	2.45	2.50	2.48
N ₄ x V ₂	8.98	9.18	9.08	84.94	85.57	85.25	2.15	2.18	2.17	1.29	1.30	1.30	2.69	2.76	2.73
SEm±	0.17	0.12	0.10	1.08	1.22	0.82	0.02	0.02	0.01	0.02	0.02	0.01	0.03	0.03	0.02
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.07	NS	NS	NS	NS	NS	NS	NS	0.07

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.25: Interaction effect of level of vermicompost and *Azotobacter* on vegetative growth of mango cv. Amrapali under HDP

Treatment	Plant Height increased (%)			Plant Spread N-S (%)			Plant Spread E-W (%)			Canopy volume (m ³)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	19.34	21.45	20.39	9.29	11.97	10.63	8.84	10.40	9.62	9.19	10.80	9.99
V ₁ x A ₀	19.92	22.83	21.37	10.36	13.21	11.78	9.82	11.51	10.67	9.95	10.93	10.44
V ₂ x A ₀	23.98	25.93	24.96	12.17	15.22	13.70	11.32	13.27	12.29	12.07	13.82	12.94
V ₀ x A ₁	19.43	22.14	20.79	9.84	12.45	11.14	9.24	10.84	10.04	9.39	10.25	9.82
V ₁ x A ₁	21.20	23.17	22.18	10.87	13.93	12.40	10.18	12.05	11.12	10.36	11.28	10.82
V ₂ x A ₁	25.52	26.24	25.88	12.43	15.47	13.95	11.88	13.68	12.78	12.26	14.00	13.13
SEm_±	0.44	0.58	0.36	0.23	0.27	0.18	0.26	0.36	0.22	0.27	0.38	0.23
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

toward the phenological observations *i.e.* plant height and plant spread (N-S), plant spread (E-W) and canopy volume (pooled over two years).

4.4.2. Interaction effect of vermicompost and *Azotobacter* on fruiting behaviour

Table 4.26 indicates that the interaction effect due to vermicomposting and *Azotobacter* did not show any significant improvement towards all fruiting behaviour except fruit set, however, the maximum value of fruit set (14.23%) was observed under the treatment combination of vermicompost @ 4.0 kg/tree+*Azotobacter* 200g/tree (pooled)

4.4.3. Interaction effect of vermicompost and *Azotobacter* on physical parameters of fruit and fruit yield

The data presented in Table 4.27a, 4.27b and 4.27c revealed that the all physical parameters of fruit and fruit yield were statistically found to be non-significant except fruits/tree due to combined application of vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled.

The plant getting In-situ vermicomposting in the absence of *Azotobacter* produced maximum number of fruits per plant (61.84), which showed statistically similar value with $V_1 \times A_0$, $V_1 \times A_1$ and $V_2 \times A_1$. The minimum number of fruits per plant (50.54) was found without vermicomposting and *Azotobacter i.e.* $V_0 \times A_0$ (pooled).

4.4.4. Interaction effect of vermicompost and *Azotobacter* on biochemical and antioxidant compounds of fruit

Data pertaining to TSS, Titratable Acidity, TSS/acidity ratio total sugar, total carotenoids and ascorbic acid as influenced by different levels of vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been presented in Table 4.28a and 4.28b.

The lowest fruit acidity (0.160%) and the highest TSS/acidity were analysed under the treatment combination of $V_1 \times A_1$ (*i.e.* vermicompost @ 4 kg/tree + *Azotobacter* @ 200g/tree), which were significantly superior over rest of the treatment combinations. However, the highest fruit acidity (0.266%) and the lowest TSS/acidity (82.66) were found under the treatment combination without vermicomposting and *Azotobacter* (pooled over two years)

4.4.5. Interaction effect of vermicompost and *Azotobacter* on total NPK content in leaves

Data presented in Table 4.29 revealed that the interaction effect due to vermicompost and *Azotobacter* showed the significant improvement towards total N, and P content in leaf at harvest stage except potassium content (pooled).

Table 4.26: Interaction effect of level of vermicompost and *Azotobacter* on fruiting behaviour of mango cv. Amrapali under HDP

Treatment	Fruit set (%)			Fruit drop (%)			Fruit retention (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	13.32	13.34	13.33	93.09	88.67	90.88	6.91	11.32	9.11
V ₁ x A ₀	13.68	13.70	13.69	92.77	89.66	91.21	7.23	10.34	8.79
V ₂ x A ₀	13.84	13.88	13.86	92.69	90.19	91.44	7.31	9.81	8.56
V ₀ x A ₁	13.03	13.05	13.04	92.96	89.87	91.42	7.04	10.21	8.63
V ₁ x A ₁	14.22	14.25	14.23	92.59	90.14	91.37	7.40	9.86	8.63
V ₂ x A ₁	13.66	13.69	13.67	92.71	89.98	91.35	7.29	10.02	8.65
SEm±	0.24	0.26	0.18	1.39	1.34	0.96	0.27	0.26	0.19
CD (P=0.05)	NS	NS	0.49	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.27a: Interaction effect of level of vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Fruit weight (g)			Fruit length (cm)			Fruit width (cm)			Volume (cm ³)			Specific gravity of Fruit		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
V ₀ x A ₀	171.99	165.63	168.81	10.55	9.47	10.01	5.99	6.01	6.00	168.83	166.56	167.70	1.003	1.013	1.008
V ₁ x A ₀	165.92	159.54	162.73	10.35	9.22	9.78	6.50	6.27	6.39	163.06	156.81	159.93	1.024	1.016	1.020
V ₂ x A ₀	165.37	157.37	161.37	10.43	9.29	9.86	6.58	6.29	6.43	162.43	154.85	158.64	1.018	1.016	1.017
V ₀ x A ₁	177.91	161.63	169.77	10.64	9.49	10.06	6.17	6.27	6.22	174.93	159.50	167.21	1.023	1.024	1.023
V ₁ x A ₁	176.44	168.22	172.33	10.51	9.35	9.93	6.70	6.30	6.50	175.26	166.09	170.68	1.011	1.012	1.012
V ₂ x A ₁	168.06	162.25	165.15	10.50	9.33	9.92	6.83	6.30	6.56	165.37	157.90	161.63	1.025	1.021	1.023
SEm±	0.27	4.32	2.16	0.50	0.42	0.11	0.11	0.17	0.28	2.68	4.08	2.44	0.03	0.04	0.02
CD (P=0.05)	0.77	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.27b: Interaction effect of level of vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp weight (g/fruit)			Stone weight (g)			Peel weight (g)			Pulp (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
V ₀ x A ₀	104.95	110.61	107.78	26.60	27.97	27.28	27.78	29.60	28.69	61.09	66.92	64.00
V ₁ x A ₀	102.43	106.30	104.37	25.51	26.66	26.09	25.45	26.57	26.01	61.76	66.74	64.25
V ₂ x A ₀	101.33	104.16	102.75	25.74	26.60	26.17	25.84	26.60	26.22	61.21	66.22	63.72
V ₀ x A ₁	110.09	107.04	108.57	27.46	26.79	27.13	27.93	27.80	27.86	61.83	66.23	64.03
V ₁ x A ₁	109.62	114.27	111.94	26.84	27.36	27.10	26.66	27.43	27.04	62.66	67.62	65.14
V ₂ x A ₁	103.88	107.06	105.47	25.90	26.78	26.34	25.78	26.75	26.27	61.83	66.79	64.31
SEm±	2.82	2.33	1.83	0.84	0.68	0.54	1.37	0.25	0.70	1.20	1.60	1.00
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	0.71	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.27c: Interaction effect of level of vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp stone ratio			Pulp peel ratio			Number of fruit /tree			Yield (kg/tree)			Yield (t/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	3.96	3.96	3.96	3.82	3.77	3.79	43.08	58.00	50.54	8.15	9.56	8.86	12.70	17.56	15.13
V ₁ x A ₀	4.06	4.04	4.05	4.05	4.02	4.04	54.59	65.50	60.05	9.00	10.38	9.69	14.02	18.89	16.45
V ₂ x A ₀	3.96	3.95	3.96	3.94	3.93	3.94	56.35	67.33	61.84	9.22	10.19	9.70	14.60	19.03	16.81
V ₀ x A ₁	4.03	4.02	4.02	3.96	3.88	3.92	49.58	63.75	56.67	8.79	10.18	9.48	13.42	18.26	15.84
V ₁ x A ₁	4.17	4.21	4.19	4.18	4.18	4.18	54.92	68.25	61.58	9.45	10.75	10.10	14.56	19.31	16.93
V ₂ x A ₁	4.05	4.04	4.04	4.06	4.02	4.04	54.27	64.08	59.18	9.01	10.20	9.60	13.99	18.75	16.37
SEm±	0.12	0.12	0.08	0.13	0.08	0.08	3.30	0.65	1.68	0.32	0.15	0.18	0.46	0.39	0.30
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	1.85	4.73	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.28a: Interaction effect of level of vermicompost and *Azotobacter* on biochemical and antioxidant compounds of mango fruit cv. Amrapali under HDP

Treatment	TSS (⁰ B)			Titratable acidity (%)			TSS/Acidity		
	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
V ₀ x A ₀	21.50	21.56	21.53	0.273	0.259	0.266	80.49	84.84	82.66
V ₁ x A ₀	21.79	21.82	21.80	0.186	0.181	0.183	120.40	124.40	122.40
V ₂ x A ₀	22.02	22.04	22.03	0.181	0.174	0.177	124.67	130.95	127.81
V ₀ x A ₁	21.64	21.66	21.65	0.240	0.225	0.232	92.94	98.95	95.94
V ₁ x A ₁	22.14	22.17	22.15	0.163	0.158	0.160	139.70	144.73	142.22
V ₂ x A ₁	21.92	21.97	21.95	0.196	0.185	0.190	115.14	122.27	118.71
SEm±	0.22	0.21	0.15	0.002	0.002	0.001	1.49	0.76	0.82
CD (P=0.05)	NS	NS	NS	0.006	0.005	0.004	4.15	2.16	2.31

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.28b: Interaction effect of level of vermicompost and *Azotobacter* on biochemical and antioxidant compounds of mango fruit cv. Amrapali under HDP

Treatment	Total sugars (%)			Total Carotenoids (mg/100g pulp)			Ascorbic Acid content (mg/100 g pulp)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	16.78	16.82	16.80	16.99	17.51	17.25	33.64	34.28	33.96
V ₁ x A ₀	17.09	17.13	17.11	17.35	17.71	17.53	34.38	35.43	34.91
V ₂ x A ₀	17.19	17.23	17.21	17.54	17.83	17.68	35.55	36.04	35.79
V ₀ x A ₁	16.93	16.95	16.94	17.20	17.61	17.40	34.03	34.89	34.46
V ₁ x A ₁	17.28	17.32	17.30	17.61	17.89	17.75	35.69	36.20	35.94
V ₂ x A ₁	17.12	17.35	17.23	17.47	17.77	17.62	35.39	35.84	35.61
SEm±	0.13	0.11	0.08	0.15	0.09	0.09	0.37	0.33	0.25
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.29: Interaction effect of level of vermicompost and *Azotobacter* on NPK content in mango leaf at harvest stage cv. Amrapali under HDP

Treatment	Total nitrogen content in leaf (%)			Total phosphorus content in leaf (%)			Total potassium content in leaf (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	1.320	1.341	1.330	0.093	0.095	0.094	0.94	0.99	0.97
V ₁ x A ₀	1.350	1.374	1.362	0.103	0.105	0.104	1.00	1.03	1.02
V ₂ x A ₀	1.400	1.418	1.409	0.105	0.121	0.113	1.04	1.06	1.05
V ₀ x A ₁	1.479	1.338	1.408	0.094	0.105	0.100	0.99	1.02	1.00
V ₁ x A ₁	1.347	1.375	1.361	0.107	0.115	0.111	1.02	1.04	1.03
V ₂ x A ₁	1.412	1.450	1.431	0.118	0.130	0.124	1.05	1.09	1.07
SEm±	0.002	0.014	0.008	0.002	0.001	0.001	0.02	0.01	0.01
CD (P=0.05)	0.005	NS	0.023	0.005	NS	0.003	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

The plant grown with in-situ vermicomposting united with *Azotobacter* @ 200 g/tree noted highest total nitrogen (1.431 %) and phosphorus (0.124%) content in leaves, which was statistically at par with $V_2 \times A_0$, and $V_1 \times A_1$ except total phosphorus. The minimum total nitrogen and phosphorus content (1.33 % and 0.094%, respectively) were found under the treatment combination without application of vermicomposting and *Azotobacter* (Pooled).

4.4.6. Interaction effect of vermicompost and *Azotobacter* on soil fertility status and microbial population at of 0-30 cm depth after fruit harvest

The pooled data over two years summarized in Table 4.30a and 4.30b revealed that the interaction effect due to vermicompost and *Azotobacter* did not show any significant improvement on the fertility status and microbial population *i.e.* pH, EC, organic carbon, available N, P_2O_5 , K_2O and *Azotobacter*, bacterial and fungal count population at 0-30 cm depth after fruit harvest except EC and *Azotobacter* population.

The maximum soil electrical conductivity (0.281 dS/m) at the depth of 0-30cm was recorded under both the treatment combinations of $V_1 \times A_1$ and $V_2 \times A_0$. Whereas, minimum soil electrical conductivity (0.261 dS/ m) was obtained with application *Azotobacter* @ 200g/tree in the absence of vermicomposting ($V_0 \times A_1$).

The highest value of *Azotobacter* population (11.25×10^4 /g soil) was found with combined application of in-situ vermicomposting unite together *Azotobacter* @ 200 g/tree ($V_2 \times A_1$), which was statistically superior over rest combination of vermicompost and *Azotobacter*.

4.4.7. Interaction effect of vermicompost and *Azotobacter* on soil fertility status and microbial population at of 30-60 cm depth after fruit harvest

A cursory glance over the pooled data presented in Table 4.31a and 4.31b revealed that the interaction effect due to vermicompost and *Azotobacter* did not show any significant improvement on the fertility status and microbial population *i.e.* pH, EC, organic carbon, available N, P_2O_5 , K_2O and *Azotobacter*, bacterial and fungal count population at 30-60 cm depth after fruit harvest except pH, which showed the maximum value (7.40) with the application of in-situ vermicomposting and *Azotobacter* @ 200g/tree ($V_2 \times A_1$).

4.4.8. Interaction effect of vermicompost and *Azotobacter* on soil fertility status and microbial population at of 60-90 cm depth after fruit harvest

Perusal of Table 4.32a and 4.32b clearly indicated that the interaction effect due to vermicompost and *Azotobacter* did not show any significant improvement on the fertility status and microbial population *i.e.* available N, P_2O_5 , K_2O and *Azotobacter*, bacterial and fungal count population at 60-90 cm depth after fruit harvest except pH, EC and organic

Table 4.30a: Interaction effect of level of vermicompost and *Azotobacter* on soil fertility status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dS/m)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	6.98	7.01	6.99	0.268	0.268	0.268	0.503	0.505	0.504	302.62	304.93	303.78
V ₁ x A ₀	6.94	6.95	6.94	0.288	0.248	0.268	0.535	0.545	0.540	303.79	306.17	304.98
V ₂ x A ₀	6.99	7.00	7.00	0.280	0.283	0.281	0.588	0.593	0.590	306.48	308.42	307.45
V ₀ x A ₁	6.84	6.88	6.86	0.265	0.258	0.261	0.505	0.510	0.508	302.79	305.44	304.11
V ₁ x A ₁	6.92	6.93	6.93	0.300	0.263	0.281	0.543	0.550	0.546	304.27	307.13	305.70
V ₂ x A ₁	7.18	7.20	7.19	0.268	0.265	0.266	0.600	0.603	0.601	306.94	308.88	307.91
SEm_±	0.06	0.08	0.05	0.004	0.003	0.004	0.008	0.007	0.005	1.40	1.09	0.89
CD (P=0.05)	0.18	NS	NS	NS	NS	0.007	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.30b: Interaction effect of level of vermicompost and *Azotobacter* on soil fertility status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ × A ₀	30.50	33.83	32.17	148.26	151.69	149.97	8.50	8.59	8.54	2.50	2.57	2.53	6.98	7.08	7.03
V ₁ × A ₀	30.65	33.94	32.29	148.76	151.76	150.26	9.13	9.27	9.20	2.62	2.67	2.65	7.64	7.70	7.67
V ₂ × A ₀	30.81	34.06	32.44	148.90	151.84	150.37	9.54	9.62	9.58	2.78	2.81	2.80	8.31	8.38	8.35
V ₀ × A ₁	30.55	33.88	32.21	148.45	151.71	150.08	9.42	9.52	9.47	2.60	2.66	2.63	7.32	7.38	7.35
V ₁ × A ₁	30.70	34.00	32.35	148.79	151.79	150.29	10.27	10.38	10.33	2.74	2.78	2.76	7.99	8.06	8.03
V ₂ × A ₁	30.87	34.11	32.49	148.93	151.88	150.40	11.21	11.28	11.25	2.83	2.86	2.84	8.57	8.63	8.60
SEm±	0.17	0.11	0.10	1.10	2.86	0.75	0.09	0.08	0.18	0.03	0.03	0.02	0.09	0.08	0.06
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.27	0.24	0.06	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.31a: Interaction effect of level of vermicompost and *Azotobacter* on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dS/m)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	7.29	7.35	7.32	0.239	0.193	0.216	0.335	0.345	0.340	134.28	134.93	134.61
V ₁ x A ₀	7.35	7.40	7.38	0.255	0.200	0.227	0.388	0.395	0.391	135.79	136.17	135.98
V ₂ x A ₀	7.21	7.26	7.24	0.258	0.198	0.228	0.408	0.415	0.411	138.42	138.42	138.42
V ₀ x A ₁	7.32	7.29	7.30	0.265	0.188	0.226	0.353	0.360	0.356	134.79	135.44	135.11
V ₁ x A ₁	7.29	7.39	7.34	0.240	0.198	0.219	0.390	0.395	0.393	136.27	136.63	136.45
V ₂ x A ₁	7.37	7.44	7.40	0.243	0.203	0.223	0.418	0.428	0.423	138.94	138.88	138.91
SEm±	0.05	0.07	0.04	0.003	0.003	0.002	0.005	0.006	0.004	0.86	0.75	0.57
CD (P=0.05)	NS	NS	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.31b: Interaction effect of level of vermicompost and *Azotobacter* on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	13.81	14.66	14.23	119.32	120.99	120.16	5.31	5.38	5.34	1.93	1.95	1.94	4.61	4.67	4.64
V ₁ x A ₀	13.90	14.78	14.34	119.47	121.05	120.26	5.39	5.45	5.42	2.02	2.04	2.03	5.04	5.12	5.08
V ₂ x A ₀	14.01	14.93	14.47	119.55	121.14	120.34	5.57	5.64	5.61	2.15	2.16	2.15	5.36	5.42	5.39
V ₀ x A ₁	13.84	14.70	14.27	119.38	121.01	120.19	5.50	5.55	5.52	1.98	2.00	1.99	4.79	4.86	4.82
V ₁ x A ₁	13.94	14.85	14.39	119.50	121.10	120.30	5.66	5.73	5.69	2.09	2.10	2.09	5.21	5.26	5.24
V ₂ x A ₁	14.08	14.99	14.54	119.61	121.17	120.39	5.85	5.98	5.91	2.16	2.18	2.17	5.51	5.56	5.53
SEm±	0.16	0.14	0.11	0.91	1.08	0.71	0.07	0.06	0.04	0.01	0.01	0.01	0.06	0.06	0.04
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.32a: Interaction effect of level of vermicompost and *Azotobacter* on soil fertility status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dS/m)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	7.13	7.38	7.25	0.24	0.13	0.18	0.135	0.138	0.136	81.50	82.08	81.79
V ₁ x A ₀	7.24	7.47	7.35	0.23	0.14	0.18	0.148	0.158	0.153	82.23	82.85	82.54
V ₂ x A ₀	7.12	7.37	7.25	0.23	0.14	0.18	0.173	0.178	0.175	83.21	84.11	83.66
V ₀ x A ₁	7.12	7.33	7.22	0.25	0.14	0.19	0.138	0.140	0.139	81.82	82.35	82.08
V ₁ x A ₁	7.10	7.36	7.23	0.24	0.14	0.19	0.158	0.160	0.159	82.45	83.11	82.78
V ₂ x A ₁	7.14	7.40	7.27	0.23	0.13	0.18	0.193	0.203	0.198	83.48	84.56	84.02
SEm_±	0.06	0.11	0.06	0.003	0.002	0.002	0.002	0.002	0.001	1.03	0.26	0.53
CD (P=0.05)	NS	NS	0.12	NS	0.005	0.005	0.006	0.006	0.004	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=Vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.32b: Interaction effect of level of vermicompost and *Azotobacter* on soil fertility status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
V ₀ x A ₀	8.53	8.78	8.65	84.71	85.26	84.98	2.13	2.16	2.14	1.04	1.05	1.05	2.27	2.31	2.29
V ₁ x A ₀	8.61	8.88	8.74	84.76	85.37	85.07	2.13	2.16	2.14	1.09	1.10	1.09	2.26	2.30	2.28
V ₂ x A ₀	8.70	9.00	8.85	84.83	85.44	85.13	2.13	2.16	2.14	1.13	1.14	1.13	2.36	2.40	2.38
V ₀ x A ₁	8.56	8.82	8.69	84.73	85.29	85.01	2.15	2.17	2.16	1.06	1.07	1.07	2.28	2.32	2.30
V ₁ x A ₁	8.63	8.94	8.78	84.78	85.39	85.09	2.13	2.16	2.14	1.10	1.11	1.10	2.32	2.37	2.34
V ₂ x A ₁	8.74	9.06	8.90	84.87	85.47	85.17	2.06	2.17	2.11	1.15	1.16	1.16	2.39	2.43	2.41
SEm±	0.12	0.08	0.07	0.76	0.87	0.58	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.05	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

carbon (pooled over two years), which recorded maximum values *i.e.* 7.35, 0.19 dS/m and 0.198 % under the treatment combination of $V_1 \times A_0$, $V_1 \times A_1$ and $V_2 \times A_1$, respectively.

4.5. Interaction effects of nitrogen, vermicompost and *Azotobacter*

4.5.1. Interaction effect of nitrogen, vermicompost and *Azotobacter* on phenological observations

The data summarized in Table 4.33, clearly indicate that the combine use of nitrogen, vermicompost and *Azotobacter* failed to touch the level of significance toward the phenological observations *i.e.* plant height and plant spread (N-S), plant spread (E-W) and canopy volume (pooled over two years).

4.5.2. Interaction effect of nitrogen, vermicompost and *Azotobacter* on flowering behaviour

The pooled data presented in Table 4.34 revealed that the days from panicle initiation to flowering influenced by different levels of nitrogen, vermicompost and *Azotobacter*. The minimum days of flowering (10.00 day) from panicle initiation was recorded with combined application of nitrogen @ 80 g/tree in the absence of vermicompost and *Azotobacter* ($N_2 \times V_0 \times A_0$), nitrogen @ 80 g/tree along with *Azotobacter* @ 200 g/tree in the absence of vermicomposting ($N_2 \times V_0 \times A_1$) and nitrogen @ 80 g/tree along with vermicompost @ 4.0 kg/tree in the absence of *Azotobacter* ($N_2 \times V_1 \times A_0$) whereas, maximum days taken in flowering from panicle initiation (15.5 day) with the combined application of nitrogen @ 120 g/tree and in-situ vermicomposting in the absence of *Azotobacter* ($N_4 \times V_2 \times A_0$).

4.5.3. Interaction effect of nitrogen, vermicompost and *Azotobacter* on fruiting behaviour

Data recorded fruit set, fruit drop and fruit retention as influenced by various interaction of nitrogen, Vermicompost and *Azotobacter* did not bring significant impact on fruiting behaviour during 2014-15, 2015-16 and pooled except fruit set which showed significant variation at pooled after two years data (Table 4.35) and gave maximum value 17.97% under treatment combination of $N_3 \times V_1 \times A_1$ (nitrogen 100 g/tree + vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree). It was statistically at par with $N_3 \times V_1 \times A_0$, $N_3 \times V_2 \times A_1$, $N_3 \times V_1 \times A_1$ and $N_4 \times V_0 \times A_0$. The lowest fruit set (8.34%) was noted with application with nitrogen @ 60g/tree in the absence of vermicomposting and *Azotobacter* ($N_1 \times V_0 \times A_0$).

Table 4.33: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on phenological observations of mango cv. Amrapali under HDP

Treatment	Plant Height increased (%)			Plant Spread N-S (%)			Plant Spread E-W (%)			Canopy volume (m ³)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ xV ₀ xA ₀	15.15	18.39	16.77	7.42	9.28	8.35	6.82	8.05	7.44	6.82	8.41	8.05
N ₁ xV ₀ xA ₁	15.94	19.54	17.74	7.86	9.78	8.82	7.22	8.50	7.86	7.69	8.69	8.32
N ₁ xV ₁ xA ₀	16.38	18.98	17.68	8.32	10.51	9.42	7.85	9.18	8.52	7.85	9.13	8.73
N ₁ xV ₁ xA ₁	16.58	19.97	18.28	8.91	11.32	10.12	8.13	9.72	8.93	8.32	9.47	9.03
N ₁ xV ₂ xA ₀	19.44	21.26	20.35	9.77	12.15	10.96	8.96	10.56	9.76	8.96	11.34	10.88
N ₁ xV ₂ xA ₁	20.52	21.38	20.95	9.96	12.54	11.25	9.32	10.93	10.13	10.41	11.56	11.06
N ₂ xV ₀ xA ₀	16.44	19.51	17.98	8.29	11.55	9.92	7.84	9.70	8.77	7.84	9.39	9.13
N ₂ xV ₀ xA ₁	16.85	19.89	18.37	8.74	12.18	10.46	8.04	10.11	9.08	8.87	9.68	9.36
N ₂ xV ₁ xA ₀	16.97	20.44	18.70	9.26	12.75	11.01	8.71	10.73	9.72	8.71	10.52	9.95
N ₂ xV ₁ xA ₁	17.36	19.96	18.66	9.58	13.21	11.40	9.10	11.16	10.13	9.38	10.72	10.32
N ₂ xV ₂ xA ₀	19.81	23.15	21.48	10.93	14.69	12.81	10.26	12.48	11.37	10.26	13.15	12.61
N ₂ xV ₂ xA ₁	23.30	23.80	23.55	11.18	14.46	12.82	10.64	12.55	11.60	12.06	13.32	12.77
N ₃ xV ₀ xA ₀	20.49	21.42	20.96	10.26	13.55	11.91	9.76	11.66	10.71	9.76	10.33	10.10
N ₃ xV ₀ xA ₁	19.22	21.91	20.56	10.89	13.30	12.10	10.53	11.92	11.22	9.87	10.59	10.35
N ₃ xV ₁ xA ₀	19.47	23.89	21.68	11.52	13.96	12.74	10.98	12.47	11.73	10.98	11.21	11.03
N ₃ xV ₁ xA ₁	22.60	24.01	23.30	11.81	14.32	13.07	11.21	12.77	11.99	10.85	11.86	11.41
N ₃ xV ₂ xA ₀	24.39	25.28	24.83	12.78	15.83	14.31	12.08	13.96	13.02	12.08	14.96	13.60
N ₃ xV ₂ xA ₁	24.78	25.49	25.14	13.12	16.34	14.73	12.76	14.55	13.66	12.23	15.16	13.86
N ₄ xV ₀ xA ₀	25.28	26.48	25.88	11.17	13.48	12.33	10.95	12.22	11.58	10.95	15.06	12.69
N ₄ xV ₀ xA ₁	25.73	27.23	26.48	11.88	14.52	13.20	11.18	12.85	12.02	10.31	12.03	11.26
N ₄ xV ₁ xA ₀	26.86	28.02	27.44	12.34	15.61	13.98	11.73	13.67	12.70	11.73	12.86	12.06
N ₄ xV ₁ xA ₁	28.25	28.73	28.49	13.18	16.86	15.02	12.29	14.58	13.43	11.26	13.08	12.53
N ₄ xV ₂ xA ₀	32.28	34.04	33.16	15.21	18.22	16.72	13.96	16.09	15.03	13.96	15.81	14.70
N ₄ xV ₂ xA ₁	33.47	34.29	33.88	15.46	18.54	17.00	14.81	16.68	15.74	13.58	15.96	14.84
SEm±	0.88	1.16	1.03	0.46	0.45	0.50	0.52	0.71	0.62	0.53	0.75	0.65
CD at (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.34: Interaction effect of nitrogen, vermicompost and *Azotobacter* on flowering behaviour of mango cv. Amrapali under HDP

Treatment	Date of panicle initiation		Date of flowering		Average days from panicle initiation to flowering
	2014-15	2015-16	2014-15	2015-16	
N ₁ XV ₀ XA ₀	26.01.2015	25.01.2016	8.02.2015	9.02.2016	14.0
N ₁ XV ₀ XA ₁	26.01.2015	26.01.2016	8.02.2015	8.02.2016	13.0
N ₁ XV ₁ XA ₀	26.01.2015	27.01.2016	8.02.2015	9.02.2016	13.0
N ₁ XV ₁ XA ₁	27.01.2015	27.01.2016	7.02.2015	7.02.2016	11.0
N ₁ XV ₂ XA ₀	28.01.2015	28.01.2016	8.02.2015	9.02.2016	11.5
N ₁ XV ₂ XA ₁	28.01.2015	29.01.2016	8.02.2015	8.02.2016	10.5
N ₂ XV ₀ XA ₀	30.01.2015	30.01.2016	9.02.2015	9.02.2016	10.0
N ₂ XV ₀ XA ₁	30.01.2015	31.01.2016	9.02.2015	10.02.2016	10.0
N ₂ XV ₁ XA ₀	30.01.2015	30.01.2016	9.02.2015	9.02.2016	10.0
N ₂ XV ₁ XA ₁	31.01.2015	1.02.2016	11.02.2015	11.02.2016	10.5
N ₂ XV ₂ XA ₀	31.01.2015	31.01.2065	11.02.2015	13.02.2016	12.0
N ₂ XV ₂ XA ₁	31.01.2015	1.01.2016	13.02.2015	14.02.2016	13.0
N ₃ XV ₀ XA ₀	2.02.2015	2.02.2016	13.02.2015	13.02.2016	11.0
N ₃ XV ₀ XA ₁	2.02.2015	2.02.2016	14.02.2015	16.02.2016	13.0
N ₃ XV ₁ XA ₀	2.02.2015	2.02.2016	15.02.2015	15.02.2016	13.0
N ₃ XV ₁ XA ₁	2.02.2015	2.02.2016	14.02.2015	16.02.2016	13.0
N ₃ XV ₂ XA ₀	2.02.2015	2.02.2016	15.02.2015	17.02.2016	14.0
N ₃ XV ₂ XA ₁	3.02.2015	3.02.2016	15.02.2015	16.02.2016	12.5
N ₄ XV ₀ XA ₀	4.02.2015	5.02.2016	18.02.2015	20.02.2016	14.5
N ₄ XV ₀ XA ₁	5.02.2015	5.02.2016	18.02.2015	19.02.2016	13.5
N ₄ XV ₁ XA ₀	5.02.2015	5.02.2016	18.02.2015	20.02.2016	14.0
N ₄ XV ₁ XA ₁	5.02.2015	4.02.2016	19.02.2015	20.02.2016	15.0
N ₄ XV ₂ XA ₀	5.02.2015	5.02.2016	20.02.2015	21.02.2016	15.5
N ₄ XV ₂ XA ₁	5.02.2015	7.02.2016	20.02.2015	21.02.2016	14.5

4.5.4. Interaction effect of nitrogen, vermicompost and *Azotobacter* on physical parameters of fruit and fruit yield

The data presented in Table 4.36a, 4.36b and 4.36c revealed that the all physical parameters of fruit and fruit yield were reported statistically non-significant with the combined application of nitrogen, vermicompost and *Azotobacter* (pooled over two years).

4.5.5. Interaction effect of nitrogen, vermicompost and *Azotobacter* on Biochemical and antioxidant compounds of fruit

Pooled data pertaining to TSS, titratable acidity, TSS/acidity ratio total sugar, total carotenoids and ascorbic acid contents presented in Table 4.37a and 4.37b did not vary significantly due to combined application of nitrogen, vermicompost and *Azotobacter* except TSS/acidity ratio, which recorded the maximum value (185.12) under the treatment

Table 4.35: Interaction effect of level nitrogen, vermicompost and *Azotobacter* on fruiting behaviour of mango cv. Amrapali under HDP

Treatment	Fruit set (%)			Fruit drop (%)			Fruit retention (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ xV ₀ xA ₀	6.82	8.35	8.34	95.19	90.15	92.67	4.81	9.82	7.32
N ₁ xV ₀ xA ₁	8.33	8.79	8.78	94.99	90.55	92.77	5.03	9.45	7.24
N ₁ xV ₁ xA ₀	7.85	9.24	9.23	94.79	91.82	93.31	5.21	8.18	6.69
N ₁ xV ₁ xA ₁	9.22	9.89	9.87	94.62	92.03	93.32	5.39	7.97	6.68
N ₁ xV ₂ xA ₀	8.96	9.48	9.47	94.83	92.48	93.66	5.17	7.52	6.34
N ₁ xV ₂ xA ₁	9.45	9.32	9.31	94.89	92.10	93.50	5.11	7.90	6.50
N ₂ xV ₀ xA ₀	7.84	11.79	11.77	93.24	89.66	91.45	6.76	10.34	8.55
N ₂ xV ₀ xA ₁	11.76	12.19	12.18	93.20	90.25	91.72	6.80	9.75	8.28
N ₂ xV ₁ xA ₀	8.71	13.03	13.02	93.04	90.20	91.62	6.96	9.80	8.38
N ₂ xV ₁ xA ₁	13.01	13.32	13.30	92.78	90.49	91.63	7.22	9.51	8.37
N ₂ xV ₂ xA ₀	10.26	13.13	13.11	92.84	91.01	91.93	7.16	8.99	8.07
N ₂ xV ₂ xA ₁	13.10	13.01	13.00	92.83	91.27	92.05	7.17	8.73	7.95
N ₃ xV ₀ xA ₀	9.76	15.98	15.97	91.42	88.90	90.16	8.58	11.10	9.84
N ₃ xV ₀ xA ₁	15.96	16.38	16.37	91.26	89.83	90.55	8.75	10.50	9.62
N ₃ xV ₁ xA ₀	10.98	17.25	17.23	91.04	89.67	90.35	8.97	10.33	9.65
N ₃ xV ₁ xA ₁	17.22	17.98	17.97	90.84	89.67	90.25	9.16	10.33	9.75
N ₃ xV ₂ xA ₀	12.08	17.58	17.55	90.88	89.34	90.11	9.12	10.65	9.89
N ₃ xV ₂ xA ₁	17.52	17.28	17.26	90.88	88.78	89.83	9.13	11.22	10.17
N ₄ xV ₀ xA ₀	10.95	17.25	17.24	92.53	85.98	89.25	7.47	14.02	10.75
N ₄ xV ₀ xA ₁	17.23	14.83	14.82	92.41	88.85	90.63	7.59	11.15	9.37
N ₄ xV ₁ xA ₀	11.73	15.29	15.28	92.21	86.93	89.57	7.79	13.07	10.43
N ₄ xV ₁ xA ₁	15.27	15.80	15.79	92.15	88.38	90.26	7.85	11.62	9.73
N ₄ xV ₂ xA ₀	13.96	15.32	15.31	92.20	87.93	90.07	7.80	12.07	9.94
N ₄ xV ₂ xA ₁	15.30	15.14	15.13	92.25	87.79	90.02	7.75	12.21	9.98
SEm±	0.43	0.52	0.50	2.78	2.67	2.73	0.54	0.53	0.54
CD at (P= 0.05)	NS	NS	1.40	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.36a: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Fruit weight (g)			Fruit length (cm)			Fruit width (cm)			Fruit Volume (cm ³)			Specific gravity		
	2014-15	2015-16	pooled	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	Pooled
N ₁ XV ₀ XA ₀	168.57	159.47	164.02	10.32	9.48	9.90	5.51	6.10	5.81	165.48	156.90	161.19	1.039	1.016	1.028
N ₁ XV ₀ XA ₁	163.80	153.37	158.58	10.36	9.18	9.77	5.68	6.14	5.91	161.22	151.17	156.19	1.020	1.047	1.033
N ₁ XV ₁ XA ₀	151.20	146.43	148.82	10.19	9.05	9.62	5.98	6.19	6.09	148.18	144.33	146.26	1.031	1.014	1.022
N ₁ XV ₁ XA ₁	182.00	176.37	179.18	10.51	9.35	9.93	6.16	6.31	6.24	178.95	173.73	176.34	1.021	1.015	1.018
N ₁ XV ₂ XA ₀	154.03	145.23	149.63	10.15	9.07	9.61	6.06	6.21	6.13	151.15	143.03	147.09	1.005	1.014	1.010
N ₁ XV ₂ XA ₁	167.73	158.67	163.20	10.33	9.14	9.74	6.28	6.24	6.26	165.45	155.63	160.54	1.023	1.021	1.022
N ₂ XV ₀ XA ₀	186.57	179.37	182.97	11.02	9.85	10.44	5.93	5.33	5.63	182.28	177.07	179.68	1.017	1.011	1.014
N ₂ XV ₀ XA ₁	193.93	174.33	184.13	11.07	9.95	10.51	6.11	6.47	6.29	190.82	172.57	181.69	1.020	1.011	1.015
N ₂ XV ₁ XA ₀	183.70	176.73	180.22	10.53	9.40	9.97	6.44	6.38	6.41	180.78	173.50	177.14	1.020	1.020	1.020
N ₂ XV ₁ XA ₁	178.00	171.13	174.57	10.44	9.29	9.86	6.63	6.35	6.49	182.05	169.07	175.56	1.016	1.011	1.013
N ₂ XV ₂ XA ₀	150.70	143.43	147.07	10.22	9.06	9.64	6.52	6.29	6.40	147.55	140.90	144.23	1.023	1.018	1.021
N ₂ XV ₂ XA ₁	146.83	143.73	145.28	10.18	9.03	9.60	6.76	6.25	6.51	144.62	141.20	142.91	1.032	1.018	1.025
N ₃ XV ₀ XA ₀	150.83	148.03	149.43	10.22	9.06	9.64	6.23	6.15	6.19	148.28	155.93	152.11	1.021	1.024	1.022
N ₃ XV ₀ XA ₁	166.87	139.63	153.25	10.31	9.19	9.75	6.42	6.06	6.24	163.68	137.20	150.44	1.034	1.017	1.025
N ₃ XV ₁ XA ₀	145.73	137.47	141.60	10.11	9.00	9.56	6.76	6.02	6.39	143.32	134.77	139.04	1.026	1.022	1.024
N ₃ XV ₁ XA ₁	143.90	133.23	138.57	10.03	8.81	9.42	6.97	5.98	6.47	141.08	131.37	136.23	0.987	1.014	1.001
N ₃ XV ₂ XA ₀	151.80	144.53	148.17	10.15	8.99	9.57	6.85	6.07	6.46	149.08	141.93	145.51	1.025	1.018	1.021
N ₃ XV ₂ XA ₁	149.07	147.50	148.28	10.20	9.04	9.62	7.10	6.08	6.59	145.92	138.20	142.06	1.027	1.024	1.026
N ₄ XV ₀ XA ₀	182.00	175.63	178.82	10.65	9.47	10.06	6.29	6.47	6.38	179.28	176.33	177.81	0.935	1.001	0.968
N ₄ XV ₀ XA ₁	187.03	179.20	183.12	10.82	9.63	10.23	6.48	6.41	6.45	183.98	177.07	180.53	1.019	1.021	1.020
N ₄ XV ₁ XA ₀	183.03	177.53	180.28	10.57	9.41	9.99	6.83	6.50	6.66	179.95	174.63	177.29	1.019	1.010	1.014
N ₄ XV ₁ XA ₁	201.87	192.13	197.00	11.07	9.95	10.51	7.03	6.55	6.79	198.95	190.20	194.58	1.018	1.009	1.014
N ₄ XV ₂ XA ₀	204.93	196.27	200.60	11.22	10.04	10.63	6.91	6.57	6.74	201.92	193.53	197.73	1.021	1.014	1.018
N ₄ XV ₂ XA ₁	208.60	199.10	203.85	11.29	10.11	10.70	7.17	6.63	6.90	205.48	196.57	201.03	1.019	1.019	1.019
SEm±	6.77	8.63	7.75	1.01	0.83	0.32	0.22	0.33	0.79	5.35	8.16	6.90	0.05	0.09	0.07
CD at (P= 0.05)	1.53	NS	NS	NS	NS	NS	NS	NS	NS	15.23	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.36b: Interaction effect of level of nitrogen, Vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp weight (g/fruit)			Stone weight (g)			Peel weight (g)			Pulp percent		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ XV ₀ XA ₀	97.81	99.49	98.65	28.03	28.57	28.30	30.22	31.40	30.81	58.03	62.39	60.21
N ₁ XV ₀ XA ₁	96.12	95.90	96.01	26.98	27.42	27.20	28.20	30.05	29.12	58.68	62.53	60.60
N ₁ XV ₁ XA ₀	90.57	95.75	93.16	23.63	24.93	24.28	24.42	25.76	25.09	59.90	65.39	62.64
N ₁ XV ₁ XA ₁	108.93	117.00	112.96	29.07	30.18	29.62	28.18	29.19	28.69	61.68	66.34	64.01
N ₁ XV ₂ XA ₀	89.81	92.29	91.05	25.76	26.40	26.08	25.96	26.54	26.25	58.30	63.55	60.93
N ₁ XV ₂ XA ₁	101.52	103.88	102.70	27.20	27.74	27.47	26.50	27.05	26.78	60.52	65.47	63.00
N ₂ XV ₀ XA ₀	114.09	117.75	115.92	28.59	29.33	28.96	30.73	32.28	31.51	61.37	65.65	63.51
N ₂ XV ₀ XA ₁	121.44	116.84	119.14	29.67	28.41	29.04	30.32	29.08	29.70	62.62	67.02	64.82
N ₂ XV ₁ XA ₀	112.99	115.85	114.42	29.80	31.82	30.81	28.42	29.06	28.74	61.51	65.55	63.53
N ₂ XV ₁ XA ₁	110.61	114.52	112.56	27.62	27.89	27.76	27.27	28.73	28.00	62.14	66.92	64.53
N ₂ XV ₂ XA ₀	92.62	96.28	94.45	22.70	23.45	23.07	22.88	23.71	23.30	61.46	67.12	64.29
N ₂ XV ₂ XA ₁	91.39	97.58	94.49	21.37	22.97	22.17	21.57	23.18	22.37	62.24	67.89	65.07
N ₃ XV ₀ XA ₀	94.40	107.79	101.10	22.02	25.12	23.57	21.92	25.32	23.62	62.59	72.81	67.70
N ₃ XV ₀ XA ₁	106.37	95.75	101.06	23.86	21.66	22.76	24.13	22.22	23.18	63.74	68.57	66.16
N ₃ XV ₁ XA ₀	92.96	95.61	94.28	20.00	20.36	20.18	20.27	21.50	20.89	63.79	69.55	66.67
N ₃ XV ₁ XA ₁	92.09	93.72	92.90	19.38	19.32	19.35	19.93	20.19	20.06	64.00	70.34	67.17
N ₃ XV ₂ XA ₀	95.50	98.79	97.15	21.65	22.49	22.07	22.17	23.25	22.71	62.91	68.36	65.63
N ₃ XV ₂ XA ₁	93.26	95.81	94.54	21.43	22.09	21.76	21.87	22.93	22.40	62.56	68.03	65.30
N ₄ XV ₀ XA ₀	113.49	117.39	115.44	27.77	28.84	28.30	28.27	29.40	28.83	62.36	66.84	64.60
N ₄ XV ₀ XA ₁	116.45	119.69	118.07	29.34	29.68	29.51	29.07	29.84	29.45	62.26	66.79	64.53
N ₄ XV ₁ XA ₀	113.21	118.00	115.61	28.63	29.55	29.09	28.70	29.98	29.34	61.85	66.47	64.16
N ₄ XV ₁ XA ₁	126.84	131.83	129.33	31.27	32.04	31.66	31.25	31.60	31.43	62.83	66.88	64.85
N ₄ XV ₂ XA ₀	127.41	129.28	128.34	32.84	34.08	33.46	32.34	32.91	32.62	62.17	65.87	64.02
N ₄ XV ₂ XA ₁	129.33	130.96	130.15	33.59	34.30	33.94	33.18	33.84	33.51	62.00	65.78	63.89
SEm±	5.64	4.66	5.97	1.67	1.36	1.52	2.74	0.50	1.97	2.40	2.21	2.83
CD at (P=0.05)	NS	NS	NS	NS	NS	NS	NS	1.42	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.36c: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on physical parameters of mango fruit cv. Amrapali under HDP

Treatment	Pulp stone ratio			Pulp peel ratio			Number of fruit /tree			Yield (kg/tree)			Yield (t/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀ x A ₀	3.49	3.48	3.49	3.24	3.17	3.20	31.65	47.00	39.33	5.64	7.52	6.58	8.38	13.26	10.82
N ₁ x V ₀ x A ₁	3.56	3.50	3.53	3.42	3.19	3.30	41.25	50.00	45.63	6.80	7.65	7.23	10.23	15.07	12.65
N ₁ x V ₁ x A ₀	3.84	3.84	3.84	3.70	3.72	3.71	45.50	54.00	49.75	6.95	7.88	7.42	11.01	15.86	13.43
N ₁ x V ₁ x A ₁	3.86	3.88	3.87	3.98	4.01	4.00	39.58	56.00	47.79	7.25	7.92	7.59	11.44	16.24	13.84
N ₁ x V ₂ x A ₀	3.49	3.50	3.49	3.46	3.48	3.47	47.67	57.00	52.33	7.30	8.25	7.78	11.06	15.81	13.43
N ₁ x V ₂ x A ₁	3.73	3.75	3.74	3.83	3.84	3.83	43.15	50.00	46.58	7.35	7.90	7.63	10.99	15.71	13.35
N ₂ x V ₀ x A ₀	3.99	4.01	4.00	3.71	3.65	3.68	38.75	47.00	42.88	6.86	8.45	7.66	11.79	16.67	14.23
N ₂ x V ₀ x A ₁	4.09	4.11	4.10	4.00	4.02	4.01	41.00	56.00	48.50	7.88	9.72	8.80	12.08	16.85	14.46
N ₂ x V ₁ x A ₀	3.80	3.64	3.72	3.98	3.99	3.98	44.25	57.00	50.63	8.17	10.12	9.15	12.74	17.54	15.14
N ₂ x V ₁ x A ₁	4.01	4.11	4.06	4.05	3.99	4.02	47.25	62.00	54.63	8.38	10.64	9.51	13.22	18.10	15.66
N ₂ x V ₂ x A ₀	4.08	4.11	4.09	4.05	4.06	4.05	55.70	73.00	64.35	8.46	10.49	9.48	12.88	18.02	15.45
N ₂ x V ₂ x A ₁	4.28	4.25	4.26	4.24	4.21	4.22	55.30	67.00	61.15	8.18	9.65	8.92	12.66	17.54	15.10
N ₃ x V ₀ x A ₀	4.29	4.29	4.29	4.31	4.26	4.28	47.42	75.00	61.21	10.21	11.15	10.68	15.23	19.98	17.61
N ₃ x V ₀ x A ₁	4.46	4.42	4.44	4.41	4.31	4.36	63.45	87.00	75.23	10.63	12.18	11.41	15.82	20.59	18.21
N ₃ x V ₁ x A ₀	4.65	4.70	4.67	4.58	4.45	4.52	73.21	83.00	78.10	10.65	11.44	11.05	16.42	21.30	18.86
N ₃ x V ₁ x A ₁	4.75	4.85	4.80	4.62	4.64	4.63	81.21	92.00	86.61	11.72	12.28	12.00	17.47	21.84	19.66
N ₃ x V ₂ x A ₀	4.41	4.39	4.40	4.31	4.25	4.28	73.90	85.33	79.62	11.19	11.38	11.29	16.85	21.66	19.26
N ₃ x V ₂ x A ₁	4.35	4.34	4.34	4.27	4.18	4.22	72.00	82.33	77.17	10.75	11.92	11.34	16.51	21.31	18.91
N ₄ x V ₀ x A ₀	4.09	4.07	4.08	4.02	3.99	4.01	54.50	63.00	58.75	9.90	11.13	10.52	15.38	20.34	17.86
N ₄ x V ₀ x A ₁	4.01	4.03	4.02	4.01	4.01	4.01	52.63	62.00	57.31	9.85	11.16	10.51	15.57	20.53	18.05
N ₄ x V ₁ x A ₀	3.95	3.99	3.97	3.94	3.94	3.94	55.42	68.00	61.71	10.21	12.07	11.14	15.90	20.86	18.38
N ₄ x V ₁ x A ₁	4.06	4.01	4.03	4.06	4.07	4.06	51.62	63.00	57.31	10.44	12.15	11.30	16.10	21.06	18.58
N ₄ x V ₂ x A ₀	3.88	3.79	3.84	3.96	3.93	3.94	48.15	54.00	51.08	9.91	10.65	10.28	17.60	20.64	19.12
N ₄ x V ₂ x A ₁	3.85	3.82	3.83	3.90	3.87	3.88	46.63	57.00	51.81	9.75	11.32	10.54	15.79	20.43	18.11
SEm±	0.24	0.23	0.24	0.26	0.17	0.22	6.61	1.03	2.38	0.65	0.30	0.50	0.92	0.78	0.85
CD at (P=0.05)	NS	NS	NS	NS	NS	NS	NS	3.70	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.37a: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on biochemical and antioxidant compounds of mango fruit cv. Amrapali under HDP

Treatment	TSS (^o B)			Tiratable acidity (%)			TSS:Acidity ratio		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ XV ₀ XA ₀	20.41	20.48	20.45	0.321	0.301	0.311	63.58	68.69	66.14
N ₁ XV ₀ XA ₁	20.69	20.64	20.67	0.285	0.270	0.278	72.58	76.37	74.48
N ₁ XV ₁ XA ₀	20.81	20.84	20.83	0.223	0.230	0.226	92.73	90.47	91.60
N ₁ XV ₁ XA ₁	21.14	21.08	21.11	0.204	0.203	0.203	103.33	100.58	101.95
N ₁ XV ₂ XA ₀	20.95	20.91	20.93	0.214	0.213	0.213	98.38	98.15	98.26
N ₁ XV ₂ XA ₁	20.88	20.96	20.92	0.226	0.224	0.225	92.70	93.89	93.30
N ₂ XV ₀ XA ₀	21.53	21.58	21.56	0.287	0.264	0.276	74.62	81.43	78.03
N ₂ XV ₀ XA ₁	21.64	21.63	21.64	0.254	0.234	0.244	85.40	92.42	88.91
N ₂ XV ₁ XA ₀	21.72	21.78	21.75	0.192	0.183	0.188	113.66	119.27	116.46
N ₂ XV ₁ XA ₁	22.13	22.16	22.15	0.162	0.155	0.159	136.34	142.35	139.35
N ₂ XV ₂ XA ₀	22.08	22.12	22.10	0.175	0.164	0.169	126.49	135.47	130.98
N ₂ XV ₂ XA ₁	22.02	22.06	22.04	0.206	0.176	0.191	106.55	125.42	115.99
N ₃ XV ₀ XA ₀	22.87	22.95	22.91	0.231	0.224	0.228	99.38	102.83	101.10
N ₃ XV ₀ XA ₁	22.98	23.04	23.01	0.193	0.184	0.189	119.71	125.52	122.62
N ₃ XV ₁ XA ₀	23.17	23.21	23.19	0.153	0.144	0.149	151.76	160.46	156.11
N ₃ XV ₁ XA ₁	23.67	23.74	23.71	0.132	0.124	0.128	178.50	191.75	185.12
N ₃ XV ₂ XA ₀	23.51	23.56	23.54	0.149	0.140	0.145	157.38	168.70	163.04
N ₃ XV ₂ XA ₁	23.39	23.45	23.42	0.151	0.148	0.149	154.90	158.43	156.67
N ₄ XV ₀ XA ₀	21.18	21.24	21.21	0.251	0.247	0.249	84.38	86.40	85.39
N ₄ XV ₀ XA ₁	21.26	21.31	21.29	0.226	0.210	0.218	94.06	101.47	97.76
N ₄ XV ₁ XA ₀	21.44	21.46	21.45	0.174	0.168	0.171	123.44	127.39	125.42
N ₄ XV ₁ XA ₁	21.62	21.69	21.66	0.153	0.150	0.152	140.65	144.25	142.45
N ₄ XV ₂ XA ₀	21.55	21.58	21.57	0.186	0.178	0.182	116.43	121.50	118.96
N ₄ XV ₂ XA ₁	21.39	21.42	21.41	0.200	0.192	0.196	106.42	111.36	108.89
SEm±	0.44	0.42	0.43	0.005	0.003	0.004	2.91	1.52	2.32
CD at (P=0.05)	NS	NS	NS	NS	NS	NS	NS	4.33	6.53

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.37b: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on biochemical and antioxidant compounds of mango fruit cv. Amrapali under HDP

Treatment	Total sugars (%)			Total Carotenoids (mg/100g pulp)			Ascorbic Acid content (mg/100 g pulp)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ xV ₀ xA ₀	15.49	15.54	15.52	15.74	16.70	16.22	27.54	29.22	28.38
N ₁ xV ₀ xA ₁	15.62	15.59	15.61	15.96	16.92	16.44	27.96	31.16	29.56
N ₁ xV ₁ xA ₀	15.78	15.80	15.79	16.14	17.07	16.61	28.73	32.55	30.64
N ₁ xV ₁ xA ₁	16.02	16.00	16.01	16.40	17.23	16.82	31.44	32.95	32.20
N ₁ xV ₂ xA ₀	15.96	15.92	15.94	16.33	17.19	16.76	31.29	32.76	32.03
N ₁ xV ₂ xA ₁	15.88	15.87	15.88	16.26	17.11	16.69	31.12	32.41	31.77
N ₂ xV ₀ xA ₀	16.74	16.78	16.76	16.88	17.61	17.25	33.56	33.86	33.71
N ₂ xV ₀ xA ₁	16.87	16.89	16.88	17.05	17.69	17.37	33.98	34.06	34.02
N ₂ xV ₁ xA ₀	17.00	17.04	17.02	17.20	17.79	17.50	34.16	34.31	34.24
N ₂ xV ₁ xA ₁	17.21	17.26	17.24	17.41	17.94	17.68	34.36	34.48	34.42
N ₂ xV ₂ xA ₀	17.13	17.16	17.15	17.36	17.88	17.62	34.23	34.31	34.27
N ₂ xV ₂ xA ₁	17.04	17.90	17.47	17.29	17.82	17.56	34.17	34.14	34.16
N ₃ xV ₀ xA ₀	17.64	17.70	17.67	17.92	18.25	18.09	36.57	37.08	36.83
N ₃ xV ₀ xA ₁	17.88	17.92	17.90	18.21	18.31	18.26	37.20	37.26	37.23
N ₃ xV ₁ xA ₀	18.09	18.16	18.13	18.43	18.40	18.42	37.54	37.68	37.61
N ₃ xV ₁ xA ₁	18.27	18.34	18.31	18.86	18.63	18.75	39.73	40.07	39.90
N ₃ xV ₂ xA ₀	18.22	18.25	18.24	18.74	18.54	18.64	39.51	39.86	39.69
N ₃ xV ₂ xA ₁	18.14	18.17	18.16	18.67	18.50	18.59	39.34	39.78	39.56
N ₄ xV ₀ xA ₀	17.24	17.27	17.26	17.41	17.48	17.45	36.88	36.94	36.91
N ₄ xV ₀ xA ₁	17.36	17.41	17.39	17.56	17.52	17.54	36.96	37.07	37.02
N ₄ xV ₁ xA ₀	17.49	17.52	17.51	17.63	17.59	17.61	37.11	37.18	37.15
N ₄ xV ₁ xA ₁	17.61	17.68	17.65	17.78	17.75	17.77	37.21	37.31	37.26
N ₄ xV ₂ xA ₀	17.44	17.59	17.52	17.72	17.71	17.72	37.15	37.23	37.19
N ₄ xV ₂ xA ₁	17.40	17.46	17.43	17.65	17.66	17.66	36.91	37.03	36.97
SEm±	0.27	0.21	0.24	0.30	0.18	0.25	0.74	0.65	0.70
CD at (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

combination of $N_3 \times V_1 \times A_1$ (nitrogen @ 100 g per tree along with vermicomposting @ 4.0 kg/tree and *Azotobacter* @ 200g per tree). The lowest TSS/acidity ratio (66.14) was noted with the plant grown under $N_1 \times V_0 \times A_0$ (*i.e.* nitrogen @ 60g/tree with absence of vermicomposting and *Azotobacter*).

4.5.6. Interaction effect of nitrogen, vermicompost and *Azotobacter* on total NPK content in leaves at harvest

Table 4.38 concerning total nitrogen, phosphorus and potassium content in leaves at harvest stage revealed that the interaction effect due to nitrogen, vermicompost and *Azotobacter* showed the significant improvement towards total N, and P except potassium content (pooled).

The plant grown with nitrogen @ 120 g/tree under In-situ vermicomposting unite together *Azotobacter* @ 200 g/tree gave the highest total nitrogen (1.560 %) and phosphorus (0.150%) content in leaves at harvest stage, however, the minimum values (1.155 % and 0.079%, respectively) were found under the treatment combination of nitrogen @ 60 g/tree along with the absence of vermicomposting and *Azotobacter* (Pooled).

4.5.7. Interaction effect of nitrogen, vermicompost and *Azotobacter* on soil fertility and microbial status at 0-30 cm depth after fruit harvest

Data summarised to soil fertility status and microbial population *i.e.* pH, EC, organic carbon, available N, P_2O_5 , K_2O and *Azotobacter*, bacterial and fungal count population at 0-30 cm depth after fruit harvest as influenced by various interaction levels of nitrogen, Vermicompost and *Azotobacter* during 2014-15, 2015-16 and pooled have been given in Table 4.39a and 4.39b.

A perusal of pooled data indicates that the combine application $N_4 \times V_2 \times A_1$ (*i.e.* nitrogen @ 120 g/tree + in-situ vermicomposting + *Azotobacter* @ 200g/tree), gave significantly the maximum soil pH (7.40), which was statistically at par to treatment combinations $N_1 \times V_2 \times A_1$, $N_2 \times V_2 \times A_1$, $N_3 \times V_1 \times A_1$, $N_3 \times V_2 \times A_1$, $N_4 \times V_0 \times A_1$, $N_4 \times V_1 \times A_1$, $N_2 \times V_0 \times A_0$, $N_3 \times V_0 \times A_0$, $N_3 \times V_2 \times A_0$, $N_4 \times V_0 \times A_0$, $N_4 \times V_1 \times A_0$, $N_4 \times V_2 \times A_0$. However, the least pH (6.60) was noted with $N_2 \times V_0 \times A_1$.

The maximum soil electrical conductivity (0.300 dS/m) was recorded with the combine application of nitrogen @ 100g/tree + in-situ vermicomposting + without *Azotobacter* ($N_3 \times V_2 \times A_0$), which was found statistically at par with the combined treatment of $N_2 \times V_2 \times A_0$, $N_3 \times V_0 \times A_0$, $N_3 \times V_1 \times A_0$, $N_2 \times V_1 \times A_1$, $N_3 \times V_0 \times A_1$, $N_3 \times V_1 \times A_1$, $N_3 \times V_2 \times A_1$ and $N_3 \times V_1 \times A_0$ (pooled).

Table 4.38: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on NPK content in mango leaf at harvest stage cv. Amrapali under HDP

Treatment	Total nitrogen content in leaf (%)			Total phosphorus content in leaf (%)			Total potassium content in leaf (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀ x A ₀	1.137	1.173	1.155	0.078	0.080	0.079	0.86	0.89	0.88
N ₁ x V ₀ x A ₁	1.900	1.210	1.555	0.084	0.091	0.088	0.88	0.91	0.90
N ₁ x V ₁ x A ₀	1.230	1.260	1.245	0.090	0.090	0.090	0.88	0.90	0.89
N ₁ x V ₁ x A ₁	1.236	1.274	1.255	0.093	0.100	0.097	0.89	0.92	0.91
N ₁ x V ₂ x A ₀	1.290	1.290	1.290	0.098	0.101	0.099	0.91	0.92	0.92
N ₁ x V ₂ x A ₁	1.310	1.330	1.320	0.100	0.110	0.105	0.91	0.94	0.93
N ₂ x V ₀ x A ₀	1.260	1.290	1.275	0.115	0.090	0.103	0.90	0.92	0.91
N ₂ x V ₀ x A ₁	1.220	1.310	1.265	0.080	0.100	0.090	0.94	0.95	0.95
N ₂ x V ₁ x A ₀	1.250	1.287	1.269	0.100	0.100	0.100	0.96	0.99	0.98
N ₂ x V ₁ x A ₁	1.210	1.244	1.227	0.100	0.110	0.105	0.92	0.96	0.94
N ₂ x V ₂ x A ₀	1.340	1.360	1.350	0.093	0.110	0.102	0.96	1.01	0.99
N ₂ x V ₂ x A ₁	1.400	1.420	1.410	0.100	0.118	0.109	0.98	1.09	1.04
N ₃ x V ₀ x A ₀	1.432	1.460	1.446	0.090	0.111	0.100	0.92	1.06	0.99
N ₃ x V ₀ x A ₁	1.310	1.340	1.325	0.113	0.118	0.116	1.03	1.07	1.05
N ₃ x V ₁ x A ₀	1.420	1.420	1.420	0.103	0.098	0.101	1.03	1.09	1.06
N ₃ x V ₁ x A ₁	1.450	1.470	1.460	0.110	0.120	0.115	1.13	1.13	1.13
N ₃ x V ₂ x A ₀	1.480	1.480	1.480	0.100	0.132	0.116	1.13	1.14	1.14
N ₃ x V ₂ x A ₁	1.442	1.490	1.466	0.130	0.130	0.130	1.14	1.14	1.14
N ₄ x V ₀ x A ₀	1.450	1.440	1.445	0.090	0.101	0.095	1.09	1.10	1.10
N ₄ x V ₀ x A ₁	1.487	1.490	1.488	0.100	0.110	0.105	1.12	1.13	1.13
N ₄ x V ₁ x A ₀	1.500	1.530	1.515	0.120	0.130	0.125	1.14	1.15	1.15
N ₄ x V ₁ x A ₁	1.490	1.510	1.500	0.125	0.132	0.128	1.13	1.14	1.14
N ₄ x V ₂ x A ₀	1.490	1.540	1.515	0.130	0.140	0.135	1.15	1.15	1.15
N ₄ x V ₂ x A ₁	1.495	1.560	1.528	0.140	0.160	0.150	1.15	1.17	1.16
SEm±	0.003	0.029	0.024	0.003	0.001	0.003	0.03	0.02	0.03
CD at (P=0.05)	0.010	NS	0.066	0.010	0.004	0.007	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.39 a: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dSm ⁻¹)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ xV ₀ xA ₀	6.64	6.63	6.63	0.28	0.26	0.27	0.50	0.50	0.50	299.26	303.24	301.25
N ₁ xV ₀ xA ₁	6.66	6.71	6.68	0.26	0.28	0.27	0.50	0.50	0.50	299.78	303.58	301.68
N ₁ xV ₁ xA ₀	6.96	6.92	6.94	0.29	0.25	0.27	0.52	0.53	0.53	300.79	304.06	302.43
N ₁ xV ₁ xA ₁	6.72	6.65	6.68	0.31	0.28	0.30	0.52	0.53	0.53	301.68	304.51	303.10
N ₁ xV ₂ xA ₀	6.94	6.90	6.92	0.25	0.29	0.27	0.55	0.57	0.56	303.05	306.28	304.67
N ₁ xV ₂ xA ₁	7.18	7.15	7.16	0.24	0.26	0.25	0.56	0.58	0.57	303.76	306.86	305.31
N ₂ xV ₀ xA ₀	7.12	7.09	7.11	0.28	0.27	0.28	0.50	0.50	0.50	301.14	303.48	302.31
N ₂ xV ₀ xA ₁	6.62	6.58	6.60	0.26	0.24	0.25	0.50	0.51	0.51	301.64	304.41	303.03
N ₂ xV ₁ xA ₀	6.75	6.68	6.72	0.28	0.24	0.26	0.53	0.54	0.54	302.96	305.53	304.25
N ₂ xV ₁ xA ₁	6.94	6.88	6.91	0.31	0.26	0.29	0.52	0.54	0.53	303.21	307.92	305.57
N ₂ xV ₂ xA ₀	6.86	6.84	6.85	0.30	0.27	0.29	0.58	0.59	0.59	306.13	307.88	307.01
N ₂ xV ₂ xA ₁	7.06	7.04	7.05	0.28	0.27	0.27	0.60	0.59	0.60	306.44	308.28	307.36
N ₃ xV ₀ xA ₀	7.06	7.11	7.09	0.27	0.30	0.29	0.50	0.51	0.51	304.94	305.88	305.41
N ₃ xV ₀ xA ₁	6.90	6.98	6.94	0.29	0.28	0.29	0.51	0.51	0.51	303.96	306.20	305.08
N ₃ xV ₁ xA ₀	6.87	6.94	6.91	0.30	0.26	0.28	0.54	0.55	0.55	304.85	306.98	305.92
N ₃ xV ₁ xA ₁	7.06	7.15	7.11	0.32	0.25	0.29	0.56	0.55	0.56	305.04	307.26	306.15
N ₃ xV ₂ xA ₀	7.08	7.12	7.10	0.31	0.29	0.30	0.60	0.59	0.60	306.93	309.16	308.05
N ₃ xV ₂ xA ₁	7.11	7.17	7.14	0.28	0.28	0.28	0.61	0.61	0.61	307.36	309.52	308.44
N ₄ xV ₀ xA ₀	7.11	7.20	7.16	0.24	0.24	0.24	0.51	0.51	0.51	305.12	307.13	306.13
N ₄ xV ₀ xA ₁	7.18	7.23	7.21	0.25	0.23	0.24	0.51	0.52	0.52	305.78	307.55	306.67
N ₄ xV ₁ xA ₀	7.16	7.25	7.21	0.28	0.24	0.26	0.55	0.56	0.56	306.55	308.09	307.32
N ₄ xV ₁ xA ₁	6.96	7.06	7.01	0.26	0.26	0.26	0.57	0.58	0.58	307.14	308.83	307.99
N ₄ xV ₂ xA ₀	7.08	7.15	7.12	0.26	0.28	0.27	0.62	0.62	0.62	309.82	310.37	310.10
N ₄ xV ₂ xA ₁	7.37	7.43	7.40	0.27	0.25	0.26	0.63	0.63	0.63	310.18	310.86	310.52
SEm±	0.12	0.16	0.14	0.007	0.007	0.007	0.013	0.015	0.014	2.80	2.18	2.51
CD at (P= 0.05)	NS	NS	0.41	NS	NS	0.020	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.39 b: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 0-30 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ xV ₀ xA ₀	30.26	33.71	31.99	148.15	151.62	149.89	7.53	7.57	7.55	2.06	2.27	2.17	5.52	5.74	5.63
N ₁ xV ₀ xA ₁	30.31	33.75	32.03	148.38	151.64	150.01	7.92	8.02	7.97	2.19	2.33	2.26	5.81	5.88	5.85
N ₁ xV ₁ xA ₀	30.38	33.83	32.11	148.67	151.69	150.18	7.82	7.94	7.88	2.21	2.35	2.28	6.12	6.15	6.14
N ₁ xV ₁ xA ₁	30.41	33.87	32.14	148.69	151.72	150.21	8.26	8.39	8.33	2.32	2.37	2.34	6.59	6.64	6.62
N ₁ xV ₂ xA ₀	30.49	33.94	32.22	148.77	151.76	150.27	8.17	8.24	8.20	2.39	2.41	2.40	6.96	7.03	7.00
N ₁ xV ₂ xA ₁	30.53	33.97	32.25	148.78	151.80	150.29	8.69	8.76	8.73	2.45	2.47	2.46	7.35	7.41	7.38
N ₂ xV ₀ xA ₀	30.41	33.79	32.10	148.19	151.67	149.93	7.92	8.06	7.99	2.50	2.51	2.51	6.49	6.56	6.53
N ₂ xV ₀ xA ₁	30.46	33.83	32.15	148.41	151.70	150.06	8.41	8.49	8.45	2.56	2.61	2.59	7.12	7.15	7.14
N ₂ xV ₁ xA ₀	30.58	33.88	32.23	148.70	151.73	150.22	8.29	8.33	8.31	2.61	2.64	2.62	7.39	7.44	7.42
N ₂ xV ₁ xA ₁	30.63	33.96	32.30	148.73	151.76	150.25	8.93	8.98	8.96	2.70	2.74	2.72	7.74	7.83	7.79
N ₂ xV ₂ xA ₀	30.75	34.04	32.40	148.82	151.82	150.32	8.74	8.81	8.78	2.73	2.78	2.76	8.18	8.25	8.22
N ₂ xV ₂ xA ₁	30.82	34.10	32.46	148.82	151.85	150.34	9.24	9.33	9.29	2.78	2.82	2.80	8.27	8.33	8.30
N ₃ xV ₀ xA ₀	30.56	33.86	32.21	148.26	151.71	149.99	8.23	8.32	8.28	2.70	2.72	2.71	7.79	7.82	7.81
N ₃ xV ₀ xA ₁	30.61	33.90	32.26	148.45	151.73	150.09	9.12	9.18	9.15	2.81	2.85	2.83	7.99	8.05	8.02
N ₃ xV ₁ xA ₀	30.72	33.95	32.34	148.77	151.78	150.28	8.86	8.97	8.92	2.79	2.82	2.80	8.14	8.19	8.17
N ₃ xV ₁ xA ₁	30.78	34.02	32.40	148.81	151.81	150.31	11.06	11.17	11.12	2.94	2.98	2.96	8.43	8.49	8.46
N ₃ xV ₂ xA ₀	30.89	34.09	32.49	148.91	151.86	150.39	9.29	9.36	9.33	2.96	2.99	2.98	8.69	8.78	8.74
N ₃ xV ₂ xA ₁	30.96	34.14	32.55	148.94	151.91	150.43	13.25	13.32	13.29	3.01	3.03	3.02	8.81	8.92	8.87
N ₄ xV ₀ xA ₀	30.78	33.96	32.37	148.44	151.74	150.09	10.30	10.41	10.36	2.73	2.78	2.75	8.12	8.18	8.15
N ₄ xV ₀ xA ₁	30.82	34.02	32.42	148.54	151.77	150.16	12.21	12.40	12.31	2.83	2.85	2.84	8.34	8.42	8.38
N ₄ xV ₁ xA ₀	30.91	34.09	32.50	148.89	151.83	150.36	11.56	11.82	11.69	2.87	2.90	2.88	8.92	9.02	8.97
N ₄ xV ₁ xA ₁	30.98	34.13	32.56	148.93	151.85	150.39	12.84	12.98	12.91	3.00	3.01	3.01	9.21	9.29	9.25
N ₄ xV ₂ xA ₀	31.11	34.17	32.64	149.11	151.92	150.52	11.98	12.08	12.03	3.04	3.07	3.05	9.41	9.47	9.44
N ₄ xV ₂ xA ₁	31.18	34.22	32.70	149.16	151.95	150.56	13.67	13.71	13.69	3.07	3.11	3.09	9.83	9.86	9.85
SEM±	0.33	0.21	0.28	2.21	5.71	2.11	0.19	0.17	0.18	0.07	0.05	0.06	0.18	0.17	0.17
CD at (P=0.05)	NS	NS	NS	NS	NS	NS	0.53	0.48	0.50	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

A perusal of pooled data indicates that the interaction effect of Nitrogen, vermicompost and *Azotobacter* showed significant variation in *Azotobacter* population. The maximum value ($13.69 \times 10^4/\text{g soil}$) was counted under with the treatment combined $N_4 \times V_2 \times A_1$, which was significantly higher over rest treatment combination except $N_3 \times V_2 \times A_1$, whereas, minimum *Azotobacter* population ($7.55 \times 10^4/\text{g soil}$) was noted under $N_1 \times V_0 \times A_0$.

However the interaction effect of nitrogen and vermicompost did not cause any significant variation in organic carbon, available N, P_2O_5 , K_2O and bacterial and fungal count population (pooled)

4.5.8. Interaction effect of nitrogen, vermicompost and *Azotobacter* on soil fertility and microbial status at 30-60 cm depth after fruit harvest

A cursory glance over the pooled data presented in Table 4.40a and 4.40b revealed that the interaction effect due to nitrogen, vermicompost and *Azotobacter* did not show any significant improvement on the fertility status and microbial population *i.e.* pH, EC, organic carbon, available N, P_2O_5 , K_2O and *Azotobacter*, bacterial and fungal count population at 30-60 cm depth after fruit harvest except electrical conductivity, which gave maximum value (0.239 dS/m) with combined application of application of nitrogen @ 80 g/tree + vermicompost @ 4.0 kg/tree in the absence of *Azotobacter* ($N_2 \times V_1 \times A_0$). It was statistically superior to rest combination of Nitrogen, vermicompost and vermicompost.

4.5.9. Interaction effect of nitrogen, vermicompost and *Azotobacter* on soil fertility and microbial status at 60-90 cm depth after fruit harvest

A cursory glance over the pooled data presented in Table 4.41a and 4.41b revealed that the interaction effect due to nitrogen, vermicompost and *Azotobacter* were not showed any significant improvement on the fertility status and microbial population *i.e.* pH, available N, P_2O_5 , K_2O and bacterial count population at 60-90 cm depth after fruit harvest except electrical conductivity, organic carbon, *Azotobacter* and fungal population,.

The maximum soil electrical conductivity (0.215 dS/m) was found with combined application of application of nitrogen 60g/tree and *Azotobacter* @ 200g/tree in the absence of vermicomposting ($N_1 \times V_0 \times A_1$), which was statistically superior over rest all the treatment combination except $N_3 \times V_2 \times A_0$. However, the lowest value of soil electrical conductivity (0.155 dS m^{-1}) was recorded with combined application of nitrogen @ 120g/tree along with in-situ vermicomposting and application of *Azotobacter* @ 200g/tree ($N_4 \times V_2 \times A_1$).

The interactive use of different levels of nitrogen, vermicompost and *Azotobacter* also touch the level of significant regarding soil organic carbon. The highest soil organic

Table 4.40a: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dSm ⁻¹)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ xV ₀ xA ₀	7.21	7.10	7.15	0.248	0.190	0.219	0.330	0.350	0.340	131.26	133.24	132.25
N ₁ xV ₀ xA ₁	7.23	7.17	7.20	0.268	0.180	0.224	0.340	0.340	0.340	131.78	133.58	132.68
N ₁ xV ₁ xA ₀	7.20	7.38	7.29	0.260	0.190	0.225	0.370	0.380	0.375	132.79	134.06	133.42
N ₁ xV ₁ xA ₁	7.31	7.61	7.46	0.240	0.210	0.225	0.370	0.370	0.370	133.68	134.51	134.10
N ₁ xV ₂ xA ₀	7.05	7.08	7.06	0.230	0.210	0.220	0.390	0.400	0.395	135.05	136.28	135.67
N ₁ xV ₂ xA ₁	7.36	7.32	7.34	0.240	0.200	0.220	0.400	0.410	0.405	135.76	136.86	136.31
N ₂ xV ₀ xA ₀	7.20	7.23	7.21	0.218	0.180	0.199	0.330	0.330	0.330	133.14	133.48	133.31
N ₂ xV ₀ xA ₁	7.19	7.17	7.18	0.270	0.190	0.230	0.350	0.360	0.355	133.64	134.41	134.03
N ₂ xV ₁ xA ₀	7.20	7.34	7.27	0.250	0.228	0.239	0.380	0.380	0.380	134.96	135.53	135.25
N ₂ xV ₁ xA ₁	7.32	7.33	7.33	0.240	0.190	0.215	0.380	0.390	0.385	135.21	135.92	135.57
N ₂ xV ₂ xA ₀	7.27	7.26	7.27	0.280	0.180	0.230	0.400	0.400	0.400	137.86	137.88	137.87
N ₂ xV ₂ xA ₁	7.39	7.42	7.40	0.240	0.210	0.225	0.410	0.420	0.415	138.44	138.28	138.36
N ₃ xV ₀ xA ₀	7.44	7.57	7.51	0.250	0.210	0.230	0.340	0.350	0.345	135.61	135.88	135.75
N ₃ xV ₀ xA ₁	7.41	7.38	7.39	0.260	0.200	0.230	0.360	0.370	0.365	135.96	136.20	136.08
N ₃ xV ₁ xA ₀	7.28	7.34	7.31	0.280	0.180	0.230	0.390	0.400	0.395	136.85	136.98	136.92
N ₃ xV ₁ xA ₁	7.24	7.29	7.26	0.230	0.210	0.220	0.390	0.400	0.395	137.04	137.26	137.15
N ₃ xV ₂ xA ₀	7.27	7.38	7.33	0.250	0.210	0.230	0.400	0.410	0.405	138.93	139.16	139.05
N ₃ xV ₂ xA ₁	7.26	7.35	7.31	0.260	0.200	0.230	0.420	0.420	0.420	139.36	139.52	139.44
N ₄ xV ₀ xA ₀	7.33	7.50	7.42	0.240	0.190	0.215	0.340	0.350	0.345	137.12	137.13	137.13
N ₄ xV ₀ xA ₁	7.44	7.42	7.43	0.260	0.180	0.220	0.360	0.370	0.365	137.78	137.55	137.67
N ₄ xV ₁ xA ₀	7.72	7.56	7.64	0.230	0.200	0.215	0.410	0.420	0.415	138.55	138.09	138.32
N ₄ xV ₁ xA ₁	7.30	7.33	7.31	0.250	0.180	0.215	0.420	0.420	0.420	139.14	138.83	138.99
N ₄ xV ₂ xA ₀	7.26	7.34	7.30	0.270	0.190	0.230	0.440	0.450	0.445	141.82	140.37	141.10
N ₄ xV ₂ xA ₁	7.47	7.67	7.57	0.230	0.200	0.215	0.440	0.460	0.450	142.18	140.86	141.52
SEm_±	0.10	0.14	0.12	0.005	0.007	0.006	0.010	0.011	0.011	1.72	0.78	1.16
CD at (P= 0.05)	NS	NS	NS	NS	NS	0.007	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.40b: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 30-60 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁶ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ ×V ₀ ×A ₀	13.540	14.430	13.985	119.23	120.92	120.08	5.21	5.26	5.24	1.55	1.56	1.56	4.14	4.19	4.17
N ₁ ×V ₀ ×A ₁	13.570	14.460	14.015	119.27	120.95	120.11	5.34	5.38	5.36	1.60	1.61	1.60	4.31	4.38	4.35
N ₁ ×V ₁ ×A ₀	13.620	14.520	14.070	119.36	120.99	120.18	5.27	5.31	5.29	1.61	1.62	1.61	4.56	4.68	4.62
N ₁ ×V ₁ ×A ₁	13.652	14.580	14.116	119.38	121.02	120.20	5.41	5.40	5.41	1.72	1.73	1.72	4.71	4.76	4.74
N ₁ ×V ₂ ×A ₀	13.730	14.660	14.195	119.43	121.07	120.25	5.35	5.39	5.37	1.79	1.81	1.80	4.78	4.84	4.81
N ₁ ×V ₂ ×A ₁	13.810	14.710	14.260	119.47	121.10	120.29	5.62	5.65	5.64	1.81	1.83	1.82	4.93	4.95	4.94
N ₂ ×V ₀ ×A ₀	13.610	14.520	14.065	119.27	120.95	120.11	5.28	5.31	5.30	1.84	1.86	1.85	4.49	4.56	4.53
N ₂ ×V ₀ ×A ₁	13.650	14.550	14.100	119.31	120.97	120.14	5.44	5.46	5.45	1.92	1.92	1.92	4.61	4.68	4.65
N ₂ ×V ₁ ×A ₀	13.730	14.650	14.190	119.39	121.01	120.20	5.35	5.36	5.36	1.99	2.01	2.00	4.88	4.94	4.91
N ₂ ×V ₁ ×A ₁	13.760	14.710	14.235	119.42	121.08	120.25	5.59	5.63	5.61	2.05	2.07	2.06	5.12	5.14	5.13
N ₂ ×V ₂ ×A ₀	13.830	14.760	14.295	119.47	121.11	120.29	5.49	5.54	5.52	2.12	2.14	2.13	5.23	5.29	5.26
N ₂ ×V ₂ ×A ₁	13.890	14.830	14.360	119.53	121.15	120.34	5.53	5.94	5.73	2.09	2.11	2.10	5.31	5.39	5.35
N ₃ ×V ₀ ×A ₀	13.980	14.710	14.345	119.36	121.02	120.19	5.33	5.41	5.37	2.13	2.15	2.14	4.73	4.79	4.76
N ₃ ×V ₀ ×A ₁	14.020	14.760	14.390	119.44	121.05	120.25	5.56	5.60	5.58	2.19	2.21	2.20	4.91	4.99	4.95
N ₃ ×V ₁ ×A ₀	14.070	14.850	14.460	119.53	121.07	120.30	5.41	5.49	5.45	2.22	2.24	2.23	5.11	5.18	5.15
N ₃ ×V ₁ ×A ₁	14.100	14.930	14.515	119.56	121.13	120.35	5.71	5.79	5.75	2.28	2.30	2.29	5.28	5.33	5.31
N ₃ ×V ₂ ×A ₀	14.170	15.010	14.590	119.59	121.15	120.37	5.58	5.67	5.63	2.31	2.32	2.32	5.45	5.52	5.49
N ₃ ×V ₂ ×A ₁	14.250	15.070	14.660	119.66	121.18	120.42	6.05	6.10	6.08	2.33	2.36	2.35	5.64	5.72	5.68
N ₄ ×V ₀ ×A ₀	14.090	14.980	14.535	119.42	121.07	120.25	5.41	5.54	5.48	2.19	2.22	2.20	5.09	5.15	5.12
N ₄ ×V ₀ ×A ₁	14.130	15.040	14.585	119.49	121.06	120.28	5.64	5.76	5.70	2.23	2.24	2.23	5.31	5.38	5.35
N ₄ ×V ₁ ×A ₀	14.180	15.110	14.645	119.61	121.13	120.37	5.53	5.63	5.58	2.26	2.28	2.27	5.59	5.68	5.64
N ₄ ×V ₁ ×A ₁	14.230	15.180	14.705	119.65	121.17	120.41	5.91	6.08	6.00	2.29	2.32	2.31	5.73	5.82	5.78
N ₄ ×V ₂ ×A ₀	14.310	15.270	14.790	119.70	121.21	120.46	5.87	5.97	5.92	2.37	2.39	2.38	5.96	6.03	6.00
N ₄ ×V ₂ ×A ₁	14.370	15.350	14.860	119.78	121.24	120.51	6.19	6.23	6.21	2.41	2.43	2.42	6.14	6.19	6.17
SEM±	0.32	0.29	0.30	1.82	1.16	2.00	0.13	0.12	0.13	0.03	0.02	0.03	0.12	0.12	0.12
CD at (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table 4.41a: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	pH			EC (dSm ⁻¹)			Organic carbon (%)			Available N (Kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ xV ₀ xA ₀	7.03	7.34	7.18	0.248	0.150	0.199	0.130	0.130	0.130	80.12	80.64	80.38
N ₁ xV ₀ xA ₁	7.19	7.42	7.31	0.260	0.170	0.215	0.130	0.130	0.130	80.41	80.90	80.66
N ₁ xV ₁ xA ₀	7.41	7.63	7.52	0.210	0.140	0.175	0.130	0.140	0.135	80.76	81.38	81.07
N ₁ xV ₁ xA ₁	7.08	7.38	7.23	0.228	0.160	0.194	0.150	0.140	0.145	80.98	81.56	81.27
N ₁ xV ₂ xA ₀	6.91	7.24	7.08	0.240	0.140	0.190	0.160	0.150	0.155	81.23	82.25	81.74
N ₁ xV ₂ xA ₁	7.11	7.44	7.28	0.250	0.130	0.190	0.160	0.170	0.165	81.55	82.44	82.00
N ₂ xV ₀ xA ₀	7.10	7.35	7.22	0.260	0.100	0.180	0.130	0.130	0.130	80.54	81.34	80.94
N ₂ xV ₀ xA ₁	7.05	7.28	7.16	0.250	0.140	0.195	0.130	0.140	0.135	80.92	81.61	81.27
N ₂ xV ₁ xA ₀	7.25	7.44	7.34	0.240	0.160	0.200	0.140	0.150	0.145	81.34	81.96	81.65
N ₂ xV ₁ xA ₁	7.10	7.35	7.23	0.230	0.150	0.190	0.140	0.150	0.145	81.52	82.15	81.84
N ₂ xV ₂ xA ₀	7.15	7.39	7.27	0.210	0.140	0.175	0.160	0.170	0.165	82.08	83.06	82.57
N ₂ xV ₂ xA ₁	7.11	7.35	7.23	0.220	0.170	0.195	0.180	0.190	0.185	82.29	83.38	82.84
N ₃ xV ₀ xA ₀	7.24	7.46	7.35	0.230	0.150	0.190	0.140	0.140	0.140	82.13	82.61	82.37
N ₃ xV ₀ xA ₁	7.13	7.38	7.25	0.240	0.138	0.189	0.140	0.140	0.140	82.38	82.93	82.66
N ₃ xV ₁ xA ₀	7.13	7.39	7.26	0.250	0.120	0.185	0.150	0.160	0.155	82.84	83.51	83.18
N ₃ xV ₁ xA ₁	7.22	7.44	7.33	0.260	0.100	0.180	0.160	0.170	0.165	83.04	83.86	83.45
N ₃ xV ₂ xA ₀	7.25	7.49	7.37	0.260	0.150	0.205	0.170	0.180	0.175	83.86	84.80	84.33
N ₃ xV ₂ xA ₁	7.17	7.42	7.29	0.250	0.130	0.190	0.200	0.210	0.205	84.11	85.48	84.80
N ₄ xV ₀ xA ₀	7.14	7.35	7.25	0.210	0.120	0.165	0.140	0.150	0.145	83.21	83.71	83.46
N ₄ xV ₀ xA ₁	7.10	7.23	7.17	0.230	0.130	0.180	0.150	0.150	0.150	83.55	83.96	83.76
N ₄ xV ₁ xA ₀	7.17	7.40	7.29	0.210	0.120	0.165	0.170	0.180	0.175	83.96	84.55	84.26
N ₄ xV ₁ xA ₁	6.98	7.25	7.11	0.230	0.140	0.185	0.180	0.180	0.180	84.24	84.88	84.56
N ₄ xV ₂ xA ₀	7.18	7.37	7.27	0.220	0.110	0.165	0.200	0.210	0.205	85.68	86.33	86.01
N ₄ xV ₂ xA ₁	7.19	7.40	7.29	0.210	0.100	0.155	0.230	0.240	0.235	85.97	86.92	86.45
SEM±	0.13	0.21	0.18	0.006	0.004	0.005	0.004	0.004	0.004	2.03	0.53	1.51
CD at (P= 0.05)	NS	NS	NS	NS	NS	0.014	0.012	NS	0.012	NS	NS	NS

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

Table4.41b: Interaction effect of level of nitrogen, vermicompost and *Azotobacter* on soil fertility status at 60-90 cm soil depth after harvest of mango cv. Amrapali under HDP

Treatment	Available P ₂ O ₅ (Kg/ha)			Available K ₂ O (Kg/ha)			<i>Azotobacter</i> population (× 10 ⁴ /g soil)			Bacterial population (× 10 ⁴ /g soil)			Fungal population (× 10 ⁴ /g soil)		
	2014-15	2015-16	Pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled	2014-15	2015-16	pooled
N ₁ x V ₀ x A ₀	8.262	8.650	8.456	84.65	85.21	84.93	2.11	2.14	2.13	0.85	0.86	0.86	2.09	2.12	2.11
N ₁ x V ₀ x A ₁	8.282	8.680	8.481	84.66	85.23	84.95	2.13	2.15	2.14	0.89	0.90	0.90	2.11	2.16	2.14
N ₁ x V ₁ x A ₀	8.340	8.730	8.535	84.70	85.28	84.99	2.12	2.13	2.13	0.92	0.93	0.93	2.15	2.19	2.17
N ₁ x V ₁ x A ₁	8.370	8.790	8.580	84.71	85.30	85.01	2.12	2.15	2.14	0.93	0.94	0.93	2.08	2.13	2.11
N ₁ x V ₂ x A ₀	8.440	8.850	8.645	84.74	85.34	85.04	2.15	2.16	2.16	0.96	0.97	0.96	2.14	2.15	2.15
N ₁ x V ₂ x A ₁	8.470	8.910	8.690	84.78	85.37	85.08	1.80	2.16	1.98	0.99	1.03	1.01	2.16	2.17	2.17
N ₂ x V ₀ x A ₀	8.372	8.710	8.541	84.68	85.24	84.96	2.13	2.17	2.15	1.04	1.04	1.04	2.18	2.19	2.19
N ₂ x V ₀ x A ₁	8.390	8.760	8.575	84.69	85.27	84.98	2.14	2.15	2.15	1.04	1.05	1.04	2.21	2.22	2.22
N ₂ x V ₁ x A ₀	8.450	8.820	8.635	84.73	85.32	85.03	2.14	2.18	2.16	1.06	1.07	1.07	2.15	2.18	2.17
N ₂ x V ₁ x A ₁	8.480	8.870	8.675	84.75	85.36	85.06	2.13	2.16	2.15	1.08	1.09	1.09	2.18	2.22	2.20
N ₂ x V ₂ x A ₀	8.560	8.930	8.745	84.79	85.41	85.10	2.11	2.15	2.13	1.10	1.11	1.10	2.20	2.24	2.22
N ₂ x V ₂ x A ₁	8.590	8.970	8.780	84.83	85.44	85.14	2.14	2.18	2.16	1.11	1.12	1.12	2.21	2.26	2.24
N ₃ x V ₀ x A ₀	8.682	8.830	8.756	84.73	85.27	85.00	2.13	2.15	2.14	1.09	1.10	1.09	2.24	2.35	2.30
N ₃ x V ₀ x A ₁	8.730	8.870	8.800	84.75	85.31	85.03	2.16	2.17	2.17	1.10	1.11	1.10	2.26	2.29	2.28
N ₃ x V ₁ x A ₀	8.770	8.930	8.850	84.79	85.37	85.08	2.11	2.14	2.13	1.13	1.13	1.13	2.12	2.18	2.15
N ₃ x V ₁ x A ₁	8.800	8.990	8.895	84.81	85.42	85.12	2.13	2.14	2.14	1.14	1.15	1.14	2.41	2.44	2.43
N ₃ x V ₂ x A ₀	8.850	9.060	8.955	84.86	85.45	85.16	2.11	2.16	2.14	1.17	1.18	1.18	2.42	2.48	2.45
N ₃ x V ₂ x A ₁	8.890	9.130	9.010	84.91	85.48	85.20	2.12	2.16	2.14	1.19	1.20	1.20	2.48	2.52	2.50
N ₄ x V ₀ x A ₀	8.820	8.910	8.865	84.77	85.32	85.05	2.14	2.18	2.16	1.20	1.21	1.21	2.57	2.58	2.58
N ₄ x V ₀ x A ₁	8.850	8.950	8.900	84.80	85.35	85.08	2.15	2.20	2.18	1.22	1.22	1.22	2.55	2.59	2.57
N ₄ x V ₁ x A ₀	8.860	9.020	8.940	84.83	85.50	85.17	2.13	2.17	2.15	1.24	1.25	1.24	2.63	2.65	2.64
N ₄ x V ₁ x A ₁	8.880	9.090	8.985	84.85	85.49	85.17	2.14	2.18	2.16	1.25	1.26	1.26	2.60	2.68	2.64
N ₄ x V ₂ x A ₀	8.960	9.152	9.056	84.92	85.55	85.24	2.14	2.17	2.16	1.28	1.29	1.28	2.67	2.74	2.71
N ₄ x V ₂ x A ₁	8.990	9.212	9.101	84.96	85.58	85.27	2.16	2.19	2.18	1.31	1.31	1.31	2.71	2.78	2.75
SEm±	0.23	0.16	0.20	1.53	1.73	1.63	0.03	0.02	0.03	0.03	0.03	0.02	0.05	0.05	0.05
CD at (P=0.05)	NS	NS	NS	NS	NS	NS	0.09	NS	0.08	NS	NS	NS	NS	NS	0.13

Note: N=Nitrogen (N₁= 60 g, N₂= 80 g, N₃= 100 g, N₄= 120 g/tree), V=vermicompost (V₀= Nil, V₁= 4 kg, V₂= In-situ @ 4 kg/tree) and A= *Azotobacter* (A₀= Nil, A₁=200g/plant)

carbon (0.235 %) was analysed with combined application of application of nitrogen @ 120 g/tree along with In-situ vermicomposting and 200 g/tree of *Azotobacter* ($N_4 \times V_2 \times A_1$), which was significantly higher over rest treatment combination.

A scrutiny of pooled data indicates that the interaction result of different levels of nitrogen, vermicompost and *Azotobacter* also did touch the level of significance on *Azotobacter* count at the depth of 60-90 cm. The maximum *Azotobacter* population (2.18×10^4 /g soil) was recorded with combined application of nitrogen @ 120 g/tree + in-situ vermicomposting along with 200 g of *Azotobacter* ($N_4 \times V_2 \times A_1$) and application of nitrogen @ 120g/tree + application of *Azotobacter* @ 200g/tree ($N_4 \times V_0 \times A_1$), while the minimum value (1.98×10^4 /g soil) was noted with the application nitrogen @ 60 g/tree + in-situ vermicomposting and *Azotobacter*@ 200g/tree ($N_1 \times V_2 \times A_1$).

The highest fungal population (2.75×10^4 /g soil) was recorded with combined application of nitrogen @ 120 g/tree along with in-situ vermicomposting and 200 g/tree of *Azotobacter* ($N_4 \times V_2 \times A_1$). This was found statistically equal with $N_4 \times V_1 \times A_0$, $N_4 \times V_1 \times A_1$ and $N_4 \times V_2 \times A_0$. However, minimum fungal population (2.11×10^4 /g soil) was noted under nitrogen @ 60 g/tree in the absence of vermicompost and *Azotobacter* (pooled over two years).



Chapter -5

Discussion

The present investigation entitled “Influence of nitrogen levels, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango (*Mangifera indica* L.) cv. Amrapali under high density planting” was carried out in the order to investigate the possibilities of enhancing the yield and quality of Amrapali mango by application of different levels of nitrogen, vermicompost and *Azotobacter*. The results of present investigation were elaborated in the preceding chapter. In this chapter scientific and logical explanation of results obtained are given for better understanding. Efforts have also been made to correlate to influence of nitrogen levels, vermicompost and *Azotobacter* with reasoning put onwards through literature available so far and comparing the result of the present studies with those of past results reported by various scientist working with in the country or abroad.

5.1. Phenological parameter

5.1.1. Influence of nitrogen on phenological parameter

The increasing levels of nitrogen (60-120g/tree) brought pronounced effect on various phenological parameters and recorded the maximum value of plant height (29.22%), canopy spread (N-S) (14.71 %), canopy spread increased (E-W) (13.42%), and canopy volume (13.01m³) with the application of nitrogen @ 120 g/tree. The progressive increase in the phenological characters with increasing levels on nitrogen might be due to the fact that the nitrogen being the constituent of nucleoprotein, amino acids and chlorophyll played a vital role in photosynthesis and enhanced the accumulation of carbohydrates which, in turn, increased the growth of plants. Similar findings have also been reported by Gautam *et al.* (2012) in mango cv. Sunderja and Patil and Shinde (2013) in banana cv. Ardhapuri.

5.1.2. Influence of vermicompost on phenological parameter

In-situ vermicomposting showed progressive improvement in various phenological characters over vermicomposting @ 4.0kg/tree and without vermicomposting. The highest increase in plant height (25.42%), canopy spread increased (N-S) (13.82 %), canopy spread increased (E-W) (12.54%), and canopy volume (13.04m³) was recorded with the application *In-situ* vermicomposting. The increase in the parameters with *In-situ* vermicompost might be *In-situ* vermicomposting enhanced plant growth with improving

soil aeration, root growth, enriched soil by micro-organisms and added plant hormones such as auxins and gibberellic acid in high. The results of present finding are in the accordance with the work of **Suthar, 2009; Parthasarathi, 2010; Parthasarathi *et al.*, 2016**. The similar findings were also found in *In-situ* earthworm breeding in papaya orchard with the work of **Humin Xiang *et al.*, (2017)**, these result is also in conformity with the findings of **Athani *et al.* (2009)** in banana cv. Rajapuri.

5.1.3. Influence of *Azotobacter* on phenological parameter

The Plant height increase (%), canopy spread E-W (%) and canopy spread N-S (%) was noted significantly influenced with the presence of *Azotobacter* and presented in Table 4.1. The data resulted that maximum value of plant height increased (22.95 %), canopy spread N-S (12.50 %) and canopy spread E-W (11.31%) was recorded with the application of *Azotobacter* @ 200g/tree, This increase in tree height and spread might be attribute *Azotobacter* bacteria utilize atmospheric nitrogen as gas for their cell protein synthesis. The cell protein is then mineralized in soil after the death of *Azotobacter* cells thereby contributing towards the nitrogen availability of the plants vigorous to growth. Similar results were also reported by **Khehra and Bal (2014)** in lemon cv. Baramasi and **Osman and Rhman (2010)**, in fig tree.

5.1.4. Interaction effect of nitrogen and vermicompost on phenological parameter

Combined effect of nitrogen and vermicompost was significantly influenced to the plant height increased (%) and canopy spread N-S (%) depicted in table. The combined application of Nitrogen @ 120g/tree along with *In-situ* vermicomposting was resulted the maximum value of plant height increased (33.52%) and canopy spread N-S (16.86%), this is might be due to earth worm activities in the *In-situ* vermicomposting improved the soil porosity and enhanced the soil nutrient to provided to better plant growth. Similar findings also were recorded papaya orchard by **Humin Xiang *et al.*, (2017)** in guava tree cv. Sardar by **Ram and Nagar (2004)**.

5.2. Fruiting behavior

5.2.1. Influence of nitrogen on fruiting behavior

Each successive levels of nitrogen showed significant impact towards fruiting behavior of mango cv. Amrapali. Among the nitrogen doses the plant treated with nitrogen @ 100 g/tree showed highest fruit set (17.06 %), fruit retention (10.03 %) and lowest fruit drop (89.97 %). The fruit drop was noted statistically at par with the application of

nitrogen @ 120g and 80g/tree, that resulted fruit drop 90.21% and 91.73% respectively. Fruit set intensity was highly dependent on concentration of nitrogen; fruit set at the lowest nitrogen treatment was very low and highest concentrations caused reductions in fruit set. This may have lead due to nitrogen is a constituent of the chlorophyll molecule and involved in nucleic acid synthesis, hence important for cell division and the growth of young tissues like buds, flowers, leaves. Similar results also in Amrapali mango by **Yadav et al. (2011)**, in sunderja mango by **Gautam et al. (2012)**.

5.2.2. Influence of vermicompost on fruiting behavior

The data in respect of fruit set percent varied significantly due to vermicomposting. The plant getting vermicompost @ 4.0 kg/tree resulted highest fruit set (13.96 %) over *In-situ* vermicomposting and in the absence of vermicompost. The increase of fruit set might be due to presence plant hormone and chemical release during biological activities promoted by the vermicompost in soil and retention of nutrients for longer period of time that accelerate the process of synthesis and accumulation of food material that reduce flower and fruit drop caused by hormonal imbalance hence maximizing fruit setting and retention. The results of present findings are in the accordance with the work of **Yadav et al. (2011)** in mango variety Amrapali, **Kumar and Kumar (2013)** in Dashehari mango, **Prakash et al. (2010)** in mango cv. Langra.

5.2.3. Interaction effect of nitrogen and vermicompost on fruiting behavior

The maximum fruit set and retention (17.60 % and 10.08 %) was recorded with the application of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg/ha. The increased fruit set and retention might be due to the enhanced availability of primary nutrients by combined action of vermicompost and microbes. The phosphatase enzyme mediated conversion on phosphorus to available form in the earthworm guts. Phosphorus is a component of key molecules such as amino acids, proteins and nucleic acids. It plays a main role in synthesis of photosynthate that optimized the fruit set and retention. This finding elucidates the reports of **Athani et al. (2007)** in guava cv. Sardar, **Thakur and Thakur (2014)** in plum cv. Santarosa, **Adak et al. (2014)**, in guava cv. Sweta.

5.2.4. Interaction effect of nitrogen and *Azotobacter* on fruiting behavior

Significantly higher fruit set (17.20 %) in Amrapali mango with the composite application of nitrogen @ 100g/tree along with *Azotobacter* @ 200g/tree. It might be possible due to fact that *Azotobacter* application improved the development of panicle and

number of leaves that was positively correlated with the number of flowers and fruit set. Similar observations were also reported by **Ahmad *et al.* (2003)**, **Yadav *et al.* (2011)** in Amrapali mango, **Tripathi *et al.* (2010)** in strawberry and **Adak *et al.* (2014)** in Sweta guava.

5.2.5. Interaction effect of vermicompost and *Azotobacter* on fruiting behavior

The fruit set percent was significantly affected by different combined treatment of vermicomposting and *Azotobacter*. Plant getting vermicompost @ 4.0 kg/tree along with *Azotobacter* @ 200 g/tree counted maximum fruit set (14.23 %). Similar results were also recorded by **Gupta and Tripathi (2012)**, **Tripathi *et al.* (2010)**, **Singh and Singh (2009)** in strawberry and **Baviskar *et al.* (2011)** in Sapota.

5.2.6. Interaction effect of Nitrogen, vermicompost and *Azotobacter* on fruiting behavior

Different treatment combination of nitrogen, vermicompost and *Azotobacter* found significant regarding to fruit set. The maximum fruit set (17.97 %) was noted with nitrogen @ 100 g/tree + vermicompost 4.0 kg/tree + *Azotobacter* @ 200 g/tree. The increase nutrient availability from nitrogen, vermicompost, and *Azotobacter* which may have increased various endogenous hormonal levels in plant tissue which might be possible for enhancing flowering pollen germination and pollen tube which might have ultimately increased fruit set and higher fruit retention. **Yadav *et al.* (2011)** and **Ahmad *et al.* (2003)** in mango cv. Amrapali also obtained similar result.

5.3. Physical parameters and yield

5.3.1. Effect of Nitrogen on Physical parameters and yield

The increasing levels of nitrogen from 60 to 120 g/tree brought prominent effect on various physiological parameters and recorded maximum value of fruit length (10.35 cm), width (6.65 cm), weight (190.61 g/fruit), volume (188.16 cm³) and pulp weight (122.82 g/fruit) of fruit with the application of nitrogen @ 120 g/tree. Whereas; the maximum pulp percent (66.44 %), pulp stone ratio (4.49), pulp peel ratio (4.38), number of fruit per tree (76.32), yield (11.29 kg/tree and 18.75 tone/hectare), minimum stone weight (21.62 g/fruit) and peel weight (22.14 g/fruit) of fruit was recorded with plant grown under application nitrogen @ 100 g/tree.

The evident effect of nitrogen on various physiological characters of fruits was due to fact that, it increased the efficiency of metabolic processes of the tree and thus encouraged the growth of the plant in general and therefore the various parts of the plant including fruit. Nitrogen has ability to produce the high rate of photosynthesis results in higher carbohydrate accumulation in fruit so increasing in fruit diameter and weight. These agreement with the findings of **Nasreen *et al.* (2014)** in mango cv. BARI Aam-1, **Satapathy and Banik (2002)** in Amrapali mango, **Madhavi *et al.* (2008)** in mango cv. Banganapalli and **Athani *et al.* (2007)**, in guava.

5.3.2. Effect of vermicompost on Physical parameters and yield

The application of vermicompost significantly influenced the physical parameters fruits. Plant grown under application of vermicompost @ 4.0 kg/tree recorded the maximum fruit width (6.50 cm), volume (167.45), weight (169.29 g/fruit) pulp weight (108.17 g/fruit) and pulp peel ratio (4.11) whereas; the minimum stone (26.25 g/fruit) and peel weight (26.24) was recorded with the application of vermicompost @ 4.0 kg/tree. The integration of organic sources of nutrients occurred due to accelerated mobility of photosynthates from source to sink. The similar results also observed by **Ghosh and Bauri (2004)** in mango cv. Himsagar, **Sharma *et al.* (2016)** in guava cv. L-49 and **Thakur and Thakur (2014)** in plum cv. Santarosa.

5.3.3. Effect of *Azotobacter* on Physical parameters and yield

The fruit volume, pulp weight, stone weight and yield significantly influenced by various level of *Azotobacter*. The highest fruit volume (166.51 cm³), pulp weight (108.66 g/fruit) and yield (9.73 kg/tree) was noted with the application of *Azotobacter* @ 200/tree although minimum stone weight was recorded in the absence of *Azotobacter*. Besides nitrogen fixing abilities of the *Azotobacter*, the capacity to releasing phyto-hormones especially gibberellins should be regarded which increases the fruit size. Also the efficient partitioning of photosynthesis towards the sink by *Azotobacter* inoculation increased the fruit size and weight. The similar findings was noted in mango c. Amrapali by **Yadav *et al.* (2011)**, **Ahmad *et al.* (2003)**, **Adak *et al.* (2014)** in guava cv. Sweta and **Athani and Hulamani (2000)** in banana cv. Rajapuri.

5.3.4. Interaction effect of nitrogen and vermicompost on Physical parameters and yield

Significantly the maximum improved regarding to fruit weight (188.64 g/fruit), length (10.25 cm) and pulp weight (122.47 g/fruit) with plat grown under combined application of nitrogen @ 120 g/tree + *In-situ* vermicomposting although the maximum pulp peel ratio (4.57), number of fruits per tree (82.35) and yield kg per tree (11.52) and minimum peel weight (20.85 g/fruit), stone weight (19.17 g/fruit) was recorded under application of nitrogen @ 100 g/tree + vermicompost @ 4.0 kg/tree.

The combination of vermicompost and nitrogen appears to be due to the added benefits of organic matter which improves the soil structure, root penetration, retention of moisture its increased availability within certain limits was appropriate to affect the yield percentage favorably. The similar result also recorded in mango cv. Sunderja by **Gautam et al. (2012)**, likewise **Kumar and Kumar (2013)** in Dashehri mango and in guava cv. Sardar by **Athani et al. (2007)**.

5.3.5. Interaction effect of nitrogen and *Azotobacter* on Physical parameters and yield

The pooled analyzed of data revealed that the interaction effect of nitrogen and *Azotobacter* showed significant variation in respect to physical parameter and yield of mango cv. Amrapali. The highest fruit weight (194.66 g/fruit) and pulp weight (125.85 g/fruit) was recorded with the combination of nitrogen @ 120 g/tree + *Azotobacter* @ 200 g/tree, whereas the minimum stone weight (21.29 g/fruit) was recorded with combination of nitrogen @ 100 g/tree + *Azotobacter* @ 200 g/tree. This increase in fruit size and weight during the present investigation might be due to the increased photosynthetic ability of plants fertilized with *Azotobacter* and nitrogen, which in turn might have favored an increased accumulation of dry matter. Similar results were obtained by **Ahmad et al. (2003)** in mango cv. Amrapali, **Baviskar et al. (2011)** in Sapota and **Hazarika et al. (2015)** in banana cv. Grand naine

5.3.6. Interaction effect of vermicompost and *Azotobacter* on Physical parameters and yield

The data in respect to number of fruit per tree was influenced by different levels of vermicompost and *Azotobacter*. The maximum number of fruit number of fruit (61.84 fruits/tree) was counted with the application of vermicompost @ 4.0 kg/tree in the absence of *Azotobacter*. These findings may be due to a better nutritional environment with

application of vermicompost improved soil health by improving the physico-chemical and biological activities and enhanced the nutrient availability to the plant, further enhanced fruit development. These agreement with the findings of **Shukla, *et al.* (2014)**, **Binopal *et al.* (2013)** and **Devi *et al.* (2012)** in Guava.

5.4. Biochemical and antioxidant compounds

5.4.1. Effect of nitrogen on biochemical and antioxidant compounds

The perusal of data in respect of biochemical and antioxidant compounds was influenced by different levels of nitrogen. The highest value of TSS (23.30 °B), TSS/Acidity ratio (144.47), Total sugars (18.07 %), Total carotenoids (18.46 mg/100 g pulp), ascorbic acid (38.47 mg/100 g pulp) and lowest value of titratable acidity (0.164 %) were recorded with application of nitrogen @ 100 g/tree. Increase in TSS, total sugar, TSS/acid ratio, total carotenoids with nitrogen application through organic and inorganic sources may be attributed to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits. Nitrogen application in form of inorganic nutrient sources might be due to the catalytic activity of several enzymes, which participate in biosynthesis of ascorbic acid and its precursor. These findings are in agreement with the **Lal And Dayal (2014)** in acid lime, **Sharma *et al.* (2016)** in guava cv. Sardar and **Dudi *et al.* (2005)** in Kinnow.

5.4.2. Effect of vermicompost on biochemical and antioxidant compounds

In-situ vermicomposting showed improvement in various biochemicals and antioxidant compounds characters over vermicomposting @ 4.0kg/tree and without vermicomposting. The maximum TSS (21.99 °B), total sugars, total carotenoids (17.65 mg/100 pulp) and ascorbic acid (35.70 mg/100 pulp) were recorded with *In-situ* vermicomposting. *In-situ* vermicomposting process always favoured formation of humic acids rich in polysaccharides, which might have resulted in the translocation of assimilates. Whereas, maximum TSS/acidity ratio, minimum titratable acidity were noted with the application of vermicompost @ 4.0 kg/tree. These results are in accordance with findings of **Mayaevi, *et al.* (2014)** in banana, **Humin Xiang *et al.* (2017)** in papaya and **Ram and Nagar (2004)** in guava cv. Allahabad Safeda.

5.4.3. Effect of *Azotobacter* on biochemical and antioxidant compounds

The titratable acidity, TSS/acidity ratio and ascorbic acid content were significantly influenced by various level of *Azotobacter*. The maximum ascorbic acid content (3.54

mg/100g pulp), TSS/acidity ratio (118.96) and minimum titratable acidity (0.194 %) was recorded with the application of *Azotobacter* @ 200 g/tree. Application of nitrogen fixing bacteria have exhibited regulatory role on the absorption and translocation of various metabolites, in which carbohydrates are most important which affects the quality of fruits. During ripening of fruits the carbohydrates reserves of the root and stem are drawn upon heavily and hydrolyzed into sugars hence results in better fruit quality. The results are in accordance with **Dutta *et al.* (2014)**, **Sharma *et al.* (2013)** in guava and **Hazarika *et al.* (2015)** in banana.

5.4.4. Interaction effect of nitrogen and vermicompost on biochemical and antioxidant compounds

With regard to the biochemical compounds like titratable acidity, TSS/acidity ratio and ascorbic acid were significantly influenced by different levels of nitrogen and vermicompost. The maximum ascorbic acid (39.62 mg/100g pulp), TSS/acidity ratio (170.62) and minimum titratable acidity were recorded with the application of nitrogen @ 100 along with vermicompost @ 4.0 kg/tree. This finding is in conformity of the result of **Baviskar *et al.* (2011)** in sapota and **Sharma *et al.* (2013)**, **Barne, *et al.* (2011)** in guava.

5.4.5. Interaction effect of nitrogen and *Azotobacter* on biochemical and antioxidant compounds

Maximum TSS/acidity ratio (154.80) significantly recorded with application of nitrogen @ 100 g/tree and *Azotobacter* @ 200 g/tree. 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. An increase in TSS contents with *Azotobacter* application may be attributed due to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits, conversion of complex polysaccharides into simple sugars. These findings are in agreement with the result of **Yadav *et al.* (2011)** in mango cv. Amrapali.

5.4.6. Interaction effect of vermicompost and *Azotobacter* on biochemical and antioxidant compounds

The maximum TSS/acidity ratio (142.22) and minimum titratable acidity (0.160 %) were recorded with plant received vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree. 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. An increase in TSS and total sugars contents with *Azotobacter* and vermicompost application may be attributed due to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits, conversion of complex polysaccharides into simple sugars. These findings are in agreement with the result of **Reddy *et al.* (2012)** in papaya cv. Surya, **Sharma *et al.* (2013)**, **Binepal *et al.* (2013)** in guava cv. Sardar and **Mayadevi, *et al.* (2014)** in litchi cv. Bombai.

5.4.7. Interaction effect of nitrogen, vermicompost and *Azotobacter* on biochemical and antioxidant compounds

It is evident of from the variance that the TSS/acidity of fruit was influenced significantly by different interaction levels of nitrogen, vermicompost and *Azotobacter*. This finding is in conformity of the result of **Sharma *et al.* (2016)**

5.5. Total nitrogen, phosphorus and potassium content in leaves

5.5.1. Effect of Nitrogen on total nitrogen, phosphorus and potassium content in leaves

The increasing levels of nitrogen (60-120g/tree) brought pronounced effect on total nitrogen, phosphorus, potassium and recorded maximum value of total nitrogen (1.50 %), phosphorus (0.12 %) and Potassium (1.14 %) with the application of nitrogen @ 120 g/tree. Higher content of nitrogen, phosphorus and potassium might be due to fact that an application of nitrogen with increasing dose increases the dry matter accumulation and nutrient concentration. The increase in uptake of these NPK might be related to the development of root and plant canopy which accelerate the absorption of nutrients. These results are in close conformity with the findings of **Singh *et al.* (2012)**.

5.5.2. Effect of Vermicompost on total nitrogen, phosphorus and potassium content in leaves

Vermicompost also brought significant change in the NPK of leaves. The maximum content of total nitrogen (1.42 %), phosphorus (0.12 %) and potassium (1.06 %) were recorded when plant nourished with *In-situ* vermicomposting. This is possibly due to the improvement in soil conditions as well as mineralization of salts, making them readily available to the plant system. This finding is in conformity of the result of **Singh *et al.* (2012)**.

5.5.3. Effect of *Azotobacter* on total nitrogen, phosphorus and potassium content in leaves

The different doses *Azotobacter* also influenced the nutrient content of leaves. The maximum total nitrogen (1.40 %), phosphorus (0.11 %) and potassium (1.03 %) content were recorded application of *In-situ* vermicomposting. Increased plant nutrient content might be due to the biological nitrogen fixation and production of enzyme complex, which solubilize the unavailable form of nutrient elements and render them available. This finding is in conformity of the result of **Marwaha, 1995**.

5.5.4. Interaction effect of nitrogen and vermicompost on total nitrogen, phosphorus and potassium content in leaves

Different levels of nitrogen and vermicompost caused significant role in total leaves nutrient content. The highest total nitrogen (1.521 %), phosphorus (0.143 %) and potassium (1.16 %) content was noted with nitrogen @ 120 g/tree + *In-situ* vermicomposting. The application of optimum dose of inorganic fertilizers along with organic manures like farmyard manure and vermicompost which might have increased the activity of beneficial microbial population resulting in increased availability of nutrient status of NPK in both soil and leaf. Similar results were also obtained by **Ranjit and Bandyopadhyay (2014)** in tomato and **Rashmi et al. (2010)** in mulberry.

5.5.5. Interaction effect of nitrogen and *Azotobacter* on total nitrogen, phosphorus and potassium content in leaves

Levels of nitrogen and *Azotobacter* also brought significant change in the total nutrient content of leaves. The maximum total nitrogen (1.505 %) and phosphorus (0.128 %) content was noted with plant grown under nitrogen @ 120 g/tree and *Azotobacter* @ 200 g/tree. These findings are in agreement with the result of **Ram et al. (2014)** in guava.

5.5.6. Interaction effect of vermicompost and *Azotobacter* on total nitrogen, phosphorus and potassium content in leaves

Higher nitrogen (1.431 %) and phosphorus (0.124 %) content in leaves was recorded with application of *In-situ* vermicomposting along with *Azotobacter* @ 200 g/tree. The addition of vermicompost and biofertilizers increased root development and water absorption in plant and nutrients which increased the nutrient contents of leaf. These findings corroborate the results of **Osman and Rhman (2010)** in fig and **Morselli et al. (2004)**.

5.5.7. Interaction effect of nitrogen, vermicompost and *Azotobacter* on total nitrogen, phosphorus and potassium content in leaves

Interaction levels of nitrogen, vermicompost and *Azotobacter* also influenced the total nitrogen and phosphorus content in leaves. The plant getting nitrogen @ 120 g/tree + *In-situ* vermicomposting + *Azotobacter* @ 200 g/tree recorded maximum nitrogen (1.528 %) and phosphorus (0.150 %) content in leaf. **Mukherjee *et al.* (1991)** and **Prasad and Singhania (1989)** also reported that application of organic manures with NKP increased the leaf nutrient status of Khasi mandarin.

5.6. Soil fertility status

5.6.1. Effect of nitrogen on soil fertility status

An analysis was carried out on the soil fertility status was influenced with different doses of nitrogen in the three distinct layers. The maximum pH (7.18), organic carbon (0.568 %), Available nitrogen (308.12 kg/ha), phosphorus (32.53 kg/ha), potassium (150.30 kg/ha), *Azotobacter* population (12.20×10^4 /g soil), bacterial population (2.94×10^6 /g soil) and fungal population (9.01×10^4 /g soil) was recorded in 0 to 30cm of soil depth. Almost similarly the trends were also noted with 30-60 and 60-90cm depth of soil. The available nitrogen status in post harvest soil increased successively with increasing nitrogen levels may only be due to integration of organic and inorganic sources as vermicomposting that favoured mineralization of organic sources of nitrogen in the soil and also increased microbial activities, which could have stimulated the nitrification process. This finding is in close conformity with the findings of **Garhwal *et al.* (2014)**, **Sharma *et al.* (2013)** in guava and **Mishra *et al.* (2011)** in ber.

5.6.2. Effect of vermicompost on soil fertility status

The data revealed that soil fertility status parameters like pH, EC, organic carbon, Available nitrogen, phosphorus, *Azotobacter* population, bacterial population and fungal population were influenced significantly with different doses of vermicompost at district depth of soil (0-30, 30-60 and 60-90 cm). the plant grown with *In-situ* vermicomposting gave the maximum pH (7.09), EC (0.274 dSm^{-1}) organic carbon (0.596 %), Available nitrogen (307.68 kg/ha), phosphorus (32.46 kg/ha), potassium (150.4 kg/ha), *Azotobacter* population (10.4×10^4 /g soil), bacterial population (2.82×10^6 /g soil) and fungal population (8.47×10^4 /g soil) in the soil depth 0-30 cm. Almost similarly the trends were also noted with 30-60 and 60-90cm depth of soil. The organic sources of nutrients capable to

supplying adequate macro and micro nutrients to the crop during whole crop period and make available more nutrients to the plant from soil with solubilization effect of plant nutrients leads to increased uptake of nutrients (**Meena et al., 2007**). The increase in the parameters may be due to the fact that vermicomposting might have increased availability of macro as well as micro nutrients in the soil and also increased microbial activities, which could have stimulated the nitrification process. These findings are also in agreement with the findings of **Dudi et al. (2004)** in kinnow mandarin and **Sharma et al. (2016)** in guava cv. L-49.

5.6.3. Effect of *Azotobacter* on soil fertility status

The highest value of *Azotobacter* population ($10.3 \times 10^4/\text{g}$ soil), bacterial population ($2.74 \times 10^6/\text{g}$ soil) and fungal population ($7.99 \times 10^4/\text{g}$ soil) at 0-30 cm depth, the highest organic carbon (0.390 %), *Azotobacter* ($5.71 \times 10^4/\text{g}$ soil), bacterial ($2.09 \times 10^6/\text{g}$ soil) and fungal ($5.20 \times 10^4/\text{g}$ soil) at the 30-60 cm depth and the maximum value of EC (1.88 dSm^{-1}), organic carbon (0.165 %), bacterial population ($1.11 \times 10^6/\text{g}$ soil) and fungal population ($2.35 \times 10^4/\text{g}$ soil) in the lower levels of soil (60-90 cm) were noted with the application of *Azotobacter* @ 200 g/tree. It may only be due to the production of enzymatic complexes by *Azotobacter*, which might have solubilized the unavailable form of nutrient to their available form and in turn increased the parameters. The results are in line with **Singh et al., 2004**.

5.6.4. Interaction effect of nitrogen and vermicompost on soil fertility status

Interaction of nitrogen @ 120 g/tree + *In-situ* vermicomposting almost improved all the soil fertility parameters like pH, *Azotobacter* population and fungal population at varying depth (0-30, 30-60 and 60-90 cm) of soil. The increase in parameters may be due to use of fertilizers with Vermicompost might have attributed to higher contribution of biomass to the soil in the form of litter and residues. However, the difference in the organic carbon content due to application of fertilizers might be resulted due to differential rate of oxidation of organic matter by microbes (**Trehan, 1997**) these findings are in close conformity with the findings of **Sharma et al. (2013)** in guava and **Singh et al. (2012)** in aonla.

5.6.5. Interaction effect of nitrogen and *Azotobacter* on soil fertility status

The interaction effect of nitrogen and *Azotobacter* almost increased all soil fertility parameters (EC and *Azotobacter* population) at the distinct depth (0-30, 30-60 and 60-90 cm) of soil. These results are in agreement with the work of **Patidar and Mali (2004)**.

5.6.6. Interaction effect of vermicompost and *Azotobacter* on soil fertility status

Electrical conductivity was improved due to the combined application of *In-situ* vermicomposting in the absence of *Azotobacter* and with vermicomposting @ 4.0 kg/tree along with *Azotobacter* @ 200 g/tree, while, *Azotobacter* population (11.25×10^4 /g soil) was improved with the application on *In-situ* vermicomposting + *Azotobacter* @ 200 g/tree at the depth of (0-30, 30-60 and 60-90 cm) depth of soil. It may be due to the fact that the application of 100 % of nitrogen was applied in the form of vermicompost increased with *Azotobacter* markedly and improve the organic carbon content in soil and thereby said parameters. The results get full support with the work of **Sharma et al. (2013)** and **Sharma et al. (2016)** in guava cv. L-49.

5.6.7. Interaction effect of nitrogen, vermicompost and *Azotobacter* on soil fertility status

Electrical conductivity was found maximum under the interaction of nitrogen @ 60 g/tree + vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree, nitrogen @ 80 g/tree + vermicompost @ 4.0 kg/tree in the absence of *Azotobacter* and nitrogen @ 60 g/tree + vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree at the depth of 0-30, 30-60 and 60-90cm depth of soil, respectively, however, the pH, *Azotobacter* population and organic carbon was obtained maximum under the treatment combination of nitrogen @ 120 g/tree + *In-situ* vermicomposting + *Azotobacter* @ 200 g/tree. These findings are agreement with **Adak et al. (2014)** and **Devi et al. (2012)** in guava.



Chapter - 6

Summary and Conclusion

The present investigation entitled “Influence of nitrogen levels, vermicompost and *Azotobacter* on phenology, yield and quality attributes of mango (*Mangifera indica* L.) cv. Amrapali under high density planting” was carried out during 2014-15 and 2015-16. The experiment was conducted at the Horticulture garden, Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural College, Sabour, Bhagalpur, Bihar India. The twenty four treatment combinations consisted of four levels of nitrogen (60, 80, 100 and 120 g/tree), three levels of Vermicompost (0, 4.0 kg/tree and In-situ vermicomposting) and two levels of *Azotobacter* (0 and 200g/tree) were arranged in factorial randomized block design with three replications. The results of the present experiment concerning to response of nitrogen, vermicompost and *Azotobacter* on phenological characters, yield, quality, leaves nutrients, soil fertility and microbial population status have been summarized in this chapter.

1. The phenological parameters like plant height, canopy spread (N-S, E-W), and canopy volume increased with the increasing levels of nitrogen (60-120g/tree). The maximum phenological parameters were recorded with the application of nitrogen @ 120 g/tree, while the minimum under application of nitrogen @ 60 g/tree.
2. The plant fed with nitrogen @ 80 g/tree took the minimum duration of flowering from panicle initiation whereas; the maximum days taken with nitrogen @ 120 g/tree.
3. The tree receiving 100 g of nitrogen increased the fruiting characters like fruit set, retention and decreased the fruit drop over rest levels of nitrogen.
4. The physical characters of fruits were influenced by different levels of nitrogen. The maximum fruit weight, fruit width, fruit volume, pulp weight, stone weight and peel weight recorded with application of nitrogen @ 120 g/tree, whereas; the maximum pulp percent, pulp stone ratio, pulp peel ratio was recorded with the application of nitrogen @ 100 g/tree.

5. The application of nitrogen @ 100 g/tree exhibited highest number of fruits, yield (kg/tree) and yield (t/ha) over rest of the levels of nitrogen, while the minimum yield was noted with the application on nitrogen @ 60 g/tree.
6. The maximum bio-chemical parameters like TSS, TSS/Acidity ratio, total sugars, total carotenoids, Ascorbic acid content and minimum Acidity were recorded with the application of nitrogen @ 100 g/tree.
7. The total NPK contents in leaves were also significantly influenced by different levels of nitrogen. Highest total NPK content were noted with the application of nitrogen @ 120 g/tree, whereas minimum was noted with the application of nitrogen @ 60 g/tree.
8. Soil fertility status also influenced in district layers (0-30, 30-60 and 60-90 cm). The maximum soil pH, organic carbon, available NPK, and microbial population were recorded with the application of nitrogen 120 g/tree. Although minimum soil fertility was obtained with 60 g of nitrogen per tree.
9. The highest values of phenological parameters like plant height, canopy spread (N-S, E-W) and canopy volume were recorded with the application of in-situ vermicomposting, while the minimum was in the absence of vermicomposting.
10. The tree receiving vermicompost @ 4.0 kg increased the fruiting characters like fruit set, retention and decreased the fruit drop overrest of the levels of vermicomposting..
11. The physical characters of fruits were also influenced by different levels of vermicomposting. The maximum fruit weight, fruit width, fruit volume, pulp weight, stone weight and peel weight were recorded with application in-situ vermicomposting, whereas; the maximum pulp percent, pulp stone ratio, pulp peel ratio were recorded with the application of vermicompost @ 4.0 kg/tree.
12. The application of vermicompost @ 4.0 kg/tree exhibited highest number of fruits, yield (kg/tree) and yield (t/ha) over rest of the level of Vermicompost, while the minimum yield was noted under the treatment without vermicomposting.
13. The maximum bio-chemical parameters like TSS, TSS/Acidity ratio, total sugars, total carotenoids, Ascorbic acid content and minimum Acidity were also recorded with the application of vermicompost @ 4.0 kg/tree.

14. The total NPK contents in leaves were also significantly influenced by different levels of vermicomposting. Highest total NPK contents were noted with the application of in-situ vermicomposting whereas, minimum were noted in the absence of vermicompost.
15. Soil fertility status also influenced at different layers (0-30, 30-60 and 60-90 cm) by different levels of vermicomposting. The maximum soil pH, organic carbon, available NPK, and microbial population were recorded with the application of in-situ vermicomposting. Although minimum soil fertility status was recorded under the treatment without vermicomposting.
16. The plant grown under application of *Azotobacter* @ 200 g/tree produced the highest values of phenological parameters like plant height, canopy spread (N-S, E-W), and canopy volume
17. The maximum fruit set, retention and minimum fruit drop were noted with tree receiving *Azotobacter* @ 200 g/tree.
18. The physical characters of fruits were also influenced by different levels of *Azotobacter*. The maximum fruit weight, fruit width, fruit volume, pulp weight, stone weight pulp percent, pulp stone ratio, pulp peel ratio and peel weight recorded with application *Azotobacter* @ 200 g/tree.
19. The application of *Azotobacter* @ 200 g/tree produced highest number of fruits, yield (kg/tree) and yield (tone/ha) over without application of *Azotobacter*, while the minimum yield was noted under the treatment without application of *Azotobacter*.
20. The bio-chemical parameters were influenced with levels of *Azotobacter*. The maximum TSS, TSS/Acidity ratio, total sugars, total carotenoids, Ascorbic acid content and minimum Acidity were also recorded with the application of *Azotobacter* @ 200 g/tree.
21. The total NPK contents in leaves were also significantly influenced by different levels of *Azotobacter*. Highest total NPK contents were noted with the application of *Azotobacter* @ 200 g/tree whereas, minimum were noted in the absence of *Azotobacter*.
22. Soil fertility status also influenced at soil depth (0-30, 30-60 and 60-90 cm) with different levels of *Azotobacter*. The maximum soil pH, organic carbon, available NPK, and microbial population were recorded with the application

of *Azotobacter* @ 200 g/tree, whereas the minimum soil fertility status was recorded under without application of *Azotobacter*.

23. The phenological parameters significantly influenced by interaction of nitrogen and vermicompost. The maximum phenological parameters like plant height, canopy spread (N-S, E-W), and canopy volume were recorded with the combined application of nitrogen @ 120 g/tree + in-situ vermicomposting, while the minimum was under the application of nitrogen @ 60 g/tree in the absence of vermicomposting.
24. The maximum fruit set, retention and minimum the fruit drop were recorded with combined application of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg/tree.
25. The physical characters of fruits were influenced by different interaction levels of nitrogen and vermicompost. The maximum fruit weight, fruit width, fruit volume, pulp weight, stone weight and peel weight recorded with application of nitrogen @ 120 g/tree + in-situ vermicomposting whereas, the maximum pulp percent, pulp stone ratio, pulp peel ratio was recorded with the application of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg/tree.
26. The application of nitrogen @ 100 g/tree + vermicompost @ 4.0 kg/tree resulted highest number of fruits, yield (kg/tree) and yield (t/ha) over rest of the levels of nitrogen and Vermicompost, while the minimum yield was noted with the application on nitrogen @ 60 g/tree in the absence of vermicompost.
27. The maximum bio-chemical parameters like TSS, TSS/Acidity ratio, total sugars, total carotenoids, Ascorbic acid content and minimum Acidity were recorded with the application of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg/tree.
28. The maximum total NPK contents in leaves were noted with the application of nitrogen @ 120 g/tree + in-situ vermicomposting whereas, the minimum were noted with application of nitrogen @ 60 g/tree in the absence of vermicomposting.
29. Soil fertility status also influenced in district layers (0-30, 30-60 and 60-90 cm) influenced by combined application of nitrogen and vermicompost. The maximum soil pH, organic carbon, available NPK, and microbial population

were recorded with the application of nitrogen 120 g/tree + in-situ vermicomposting.

30. The highest values of phenological parameters like plant height, canopy spread (N-S, E-W), and canopy volume were recorded with the application of nitrogen @ 120 g/tree + *Azotobacter* @ 200 g/tree, while the minimum was noted with the application of nitrogen @ 60 g/tree in the absence of *Azotobacter*.
31. The tree receiving nitrogen @ 100 g/tree + *Azotobacter* @ 200 g/tree increased the fruiting characters like fruit set retention and decreased the fruit drop over rest of the interactions of nitrogen and *Azotobacter*.
32. The physical characters of fruits were also influenced by different interaction levels of nitrogen and *Azotobacter*. The maximum fruit weight, fruit width, fruit volume, pulp weight, stone weight and peel weight recorded with the application nitrogen @ 120 g/tree along with *Azotobacter* @ 200 g/tree, whereas; the maximum pulp percent, pulp stone ratio, pulp peel ratio was recorded with the application of nitrogen @ 100 g/tree in the presence of *Azotobacter* @ 200 g/tree.
33. The plant received combination of nitrogen @ 100 g/tree + *Azotobacter* @ 200 g/tree exhibited highest number of fruits, yield (kg/tree) and yield (tone/ha) over rest of the interactions of nitrogen and *Azotobacter*.
34. The maximum bio-chemical parameters like TSS, TSS/Acidity ratio, total sugars, total carotenoids, Ascorbic acid content and minimum Acidity were also recorded with the application of nitrogen @ 100 g/tree + *Azotobacter* @ 200 g/tree.
35. The NPK contents in leaves were also significantly influenced by different interaction levels of nitrogen and *Azotobacter*. Highest total NPK contents were noted with the application of nitrogen @ 120 g/tree along with *Azotobacter* @ 200 g/tree
36. The maximum soil pH, organic carbon, available NPK, and microbial population were recorded with the application of nitrogen @ 120 g/tree along with *Azotobacter* @ 200 g/tree. Although minimum soil fertility status was recorded under the treatment with nitrogen @ 60 g/tree in the absence of *Azotobacter*.

37. The plant grown under combined application of in-situ vermicomposting + *Azotobacter* @ 200 g/tree produced the highest plant height, canopy spread (N-S, E-W), and canopy volume
38. The maximum fruit set, retention and minimum fruit drop were noted with tree receiving vermicomposting @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree, while minimum fruit set, retention and maximum fruit drop were noted in the absence of vermicompost and *Azotobacter*.
39. The maximum fruit weight, fruit width, fruit volume, pulp weight, stone weight pulp percent, pulp stone ratio, pulp peel ratio and peel weight were recorded with the application of in-situ vermicomposting + *Azotobacter* @ 200 g/tree.
40. The application of vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree produced highest number of fruits, yield (kg/tree) and yield (tone/ha) over rest level of vermicompost and *Azotobacter*, while the minimum yield was noted under the treatment without application of vermicomposting and *Azotobacter*.
41. The bio-chemical parameters were influenced with interactions of vermicompost and *Azotobacter*. The maximum TSS, TSS/Acidity ratio, total sugars, total carotenoids, Ascorbic acid content and the minimum Acidity were also recorded with the application of vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree.
42. Highest total NPK contents were noted with the application of In-situ vermicomposting + *Azotobacter* @ 200 g/tree whereas, minimum were noted in the absence of vermicompost and *Azotobacter*.
43. Soil fertility status also influenced at soil depth (0-30, 30-60 and 60-90 cm) with different interactions of vermicompost and *Azotobacter*. The maximum soil pH, organic carbon, available NPK, and microbial population were recorded with the application of in-situ vermicomposting + *Azotobacter* @ 200 g/tree, whereas, the minimum soil fertility status was recorded under the treatment without vermicomposting and *Azotobacter*.
44. The maximum phenological parameters like plant height, canopy spread (N-S, E-W), and canopy volume were recorded with the application of nitrogen @ 120 g/tree + in-situ vermicomposting + *Azotobacter* @ 200 g/tree, while the

minimum was noted under the application of nitrogen @ 60 g/tree in the absence of vermicomposting and *Azotobacter*.

45. The maximum fruit set, retention and minimum the fruit drop were recorded with the application of nitrogen @ 100 g/tree + vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree.
46. The physical characters of fruits were influenced by different interaction levels of nitrogen, vermicompost and *Azotobacter*. The maximum fruit weight, fruit width, fruit volume, pulp weight, stone weight and peel weight were recorded with application of nitrogen @ 120 g/tree + in-situ vermicomposting + *Azotobacter* @ 200 g/tree, whereas, the maximum pulp percent, pulp stone ratio, pulp peel ratio was recorded with the application of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree.
47. The application of nitrogen @ 100 g/tree + vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree resulted the highest number of fruits, yield (kg/tree) and yield (tone/ha) over rest of the interactions of nitrogen, vermicompost and *Azotobacter*. While the minimum yield was noted with the application on nitrogen @ 60 g/tree in the absence of vermicompost and *Azotobacter*.
48. The maximum bio-chemical parameters like TSS, TSS/Acidity ratio, total sugars, total carotenoids, Ascorbic acid content and minimum Acidity were recorded with the application of nitrogen @ 100 g/tree along with vermicompost @ 4.0 kg/tree + *Azotobacter* @ 200 g/tree.
49. The maximum total NPK contents in leaves were noted with the combined application of nitrogen @ 120 g/tree + in-situ vermicompost + *Azotobacter* @ 200 g/tree whereas, the minimum were noted with the application of nitrogen @ 60 g/tree in the absence of vermicomposting *Azotobacter*.
50. Soil fertility status also influenced in district layers (0-30, 30-60 and 60-90 cm) influenced by combined application of nitrogen, vermicompost and *Azotobacter*. The maximum soil pH, organic carbon, available NPK, and microbial population were recorded with the application of nitrogen 120 g/tree + in-situ vermicomposting + *Azotobacter* @ 200 g/tree.

On the basis of above findings it can be concluded that application of nitrogen @ 120 g/tree inhibited the fruit of largest size. The highest number of fruit increased with application on nitrogen @ 100 g/tree. However, over all

yield and quality was obtained to better with the combined application of nitrogen @ 100 g/tree + vermicompost @ 4.0 kg/tree along with *Azotobacter* @ 200 g/tree.

The finding is on the basis of two year experiment. Further standardize of phosphorus and potassium is needed in mango under high density planting.



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Appendices

APPENDIX

Appendix : Analysis of variance (Mean sum of square) Pooled (2014-15 and 2015-16).

Source of variation	Y	R(Y)	N	V	A	YxN	YxV	YxA	NxV	NxA	VxA	YxNxV	YxNxA	YxVxA	NxVxA	YxNxVxA	Error
(d.f.) characters	(1)	(4)	(2)	(3)	(2)	(3)	(2)	(1)	(6)	(3)	(2)	(6)	(3)	(2)	(6)	(6)	(92)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A. Vegetative growth																	
Plant Height increased (%)	153.21	10.08	810.41	303.70	18.07	4.53	4.73	2.46	10.83	0.17	0.93	1.25	0.65	2.90	2.08	52.38	3.16
Plant Spread N-S (%)	298.51	0.08	161.46	104.78	7.69	2.41	0.54	0.02	1.85	0.36	0.42	0.29	0.11	0.07	0.15	99.61	0.75
Plant Spread E-W (%)	109.77	0.26	152.20	89.01	7.41	0.57	0.27	0.00	1.21	0.16	0.01	0.09	0.05	0.09	0.07	36.64	1.17
Canopy volume (m ³)	61.67	1.35	87.17	128.90	0.63	3.83	1.94	0.67	0.58	0.66	0.95	1.75	0.93	0.53	0.74	21.18	1.27
B. Fruiting behavior																	
Fruit set (%)	0.03	0.74	436.09	7.87	0.02	0.00	0.00	0.00	3.30	2.09	2.47	0.00	0.00	0.00	2.04	0.01	0.74
Fruit drop (%)	335.13	22.18	81.36	0.72	1.42	14.41	4.58	3.09	0.92	0.95	1.19	0.78	0.76	1.84	0.26	111.99	22.29
Fruit retention (%)	337.87	0.62	82.11	0.85	1.21	13.96	4.90	2.79	0.83	1.03	1.01	0.71	0.83	1.66	0.27	112.90	0.86
C. Physical parameters of fruit																	
Fruit weight (g)	2606.10	662.35	12249.40	461.38	823.69	5.67	71.66	91.52	2110.22	429.17	232.74	29.96	16.29	113.84	322.78	911.07	180.42
Fruit length (cm)	46.95	5.44	3.91	0.44	0.26	0.01	0.00	0.01	0.97	0.14	0.04	0.01	0.01	0.00	0.12	15.66	0.32
Fruit width (cm)	1.80	0.03	2.10	2.11	0.85	1.26	0.75	0.11	0.04	0.07	0.04	0.05	0.07	0.08	0.10	0.70	0.24
Volume (cm ³)	2319.23	3729.74	12229.07	679.22	702.69	8.39	6.21	254.67	2088.68	462.91	396.21	21.91	49.29	144.83	248.77	834.50	142.88
Specific gravity of Fruit (g/cm ³)	0.000	0.127	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.001	0.002	0.001	0.001	0.000	0.001	0.001	0.015
Pulp weight (g/fruit)	293.69	94.56	5020.21	263.43	491.40	3.06	26.43	57.37	781.94	228.75	146.54	11.21	38.14	86.12	132.86	123.79	80.33
Stone weight (g)	16.90	4.85	534.84	11.17	4.14	0.26	1.03	7.04	90.10	21.51	4.33	0.58	1.43	3.29	12.91	7.27	6.98
Peel weight (g)	28.24	7.56	470.63	58.30	0.24	0.16	0.04	4.40	84.06	11.04	10.37	0.61	2.09	3.76	4.59	11.35	11.66
Pulp percent	908.82	61.76	123.91	7.41	9.08	7.69	0.08	2.28	9.84	5.74	2.33	2.14	1.45	1.95	1.27	305.11	24.11
Pulp stone ratio	0.001	0.231	4.255	0.245	0.329	0.002	0.003	0.002	0.360	0.063	0.020	0.004	0.003	0.004	0.039	0.008	0.168
Pulp peel ratio	0.044	0.045	3.811	0.750	0.555	0.006	0.008	0.000	0.332	0.110	0.004	0.007	0.003	0.002	0.055	0.021	0.147
fruits /tree	5494.33	1312.55	5758.55	798.57	99.78	62.00	52.11	0.26	374.03	124.07	232.14	69.71	3.75	11.59	59.58	1854.97	68.04
Yield (kg/tree)	58.49	0.25	114.54	6.48	3.51	1.84	0.34	0.01	0.98	0.33	1.67	0.27	0.44	0.07	0.57	19.74	0.76
Yield (t/ha)	813.54	2.21	279.38	21.48	2.23	0.15	0.22	0.03	1.07	1.36	4.51	0.37	0.23	0.17	0.53	271.37	2.17

D. bio-chemical compounds in fruit																	
TSS (°B)	0.045	0.128	40.025	2.492	0.585	0.005	0.000	0.001	0.058	0.032	0.572	0.001	0.001	0.005	0.025	0.018	0.548
Titratable acidity (%)	0.003	0.000	0.038	0.083	0.008	0.000	0.000	0.000	0.001	0.000	0.007	0.000	0.000	0.000	0.000	0.001	0.000
TSS/Acidity	1076.17	7.48	21803.92	24674.40	2303.59	117.60	15.17	12.48	782.49	186.95	2760.61	37.01	7.11	0.54	81.64	380.17	16.20
Total sugars (%)	0.180	0.082	33.312	1.867	0.504	0.050	0.042	0.029	0.080	0.045	0.087	0.043	0.047	0.042	0.046	0.106	0.173
Total Carotnoids (mg/100gpulp)	4.72	0.04	21.04	1.65	0.38	1.90	0.10	0.03	0.04	0.01	0.26	0.02	0.01	0.01	0.01	1.58	0.18
Ascorbic Acid content (mg/100 g pulp)	16.10	2.24	420.34	30.43	7.37	9.00	0.34	0.12	6.98	1.84	4.46	0.37	0.05	0.44	1.13	6.18	1.45
E. NPK content in leaf at harvest stage																	
Nitrogen	0.000	0.018	0.350	0.048	0.039	0.034	0.030	0.019	0.026	0.055	0.020	0.032	0.035	0.031	0.052	0.036	0.002
Phosphorus	0.002	0.000	0.006	0.005	0.002	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
Potassium	0.033	0.007	0.414	0.059	0.017	0.002	0.000	0.000	0.005	0.002	0.002	0.003	0.003	0.002	0.003	0.011	0.002
F. Soil fertility status at 0-30 cm soil depth after harvest of fruit																	
pH	0.014	0.171	0.928	0.422	0.007	0.033	0.001	0.000	0.066	0.012	0.333	0.002	0.001	0.000	0.204	0.005	0.063
EC (dSm ⁻¹)	0.007	0.000	0.006	0.001	0.000	0.001	0.005	0.000	0.001	0.000	0.003	0.001	0.000	0.000	0.001	0.003	0.000
Organic carbon (%)	0.001	0.000	0.009	0.098	0.002	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Available N (Kg/ha)	198.414	27.334	168.138	171.149	9.173	6.668	1.541	0.673	1.646	0.770	0.467	1.123	0.557	0.178	0.260	66.541	18.943
Available P ₂ O ₅ (Kg/ha)	388.961	0.077	1.071	0.895	0.097	0.158	0.021	0.000	0.004	0.001	0.000	0.003	0.000	0.000	0.000	129.654	0.233
Available K ₂ O (Kg/ha)	345.046	8.076	0.283	1.636	0.109	0.040	0.567	0.022	0.005	0.000	0.022	0.003	0.000	0.028	0.001	115.017	13.353
<i>Azotobacter</i> population (× 10 ⁴ /g soil)	0.347	0.108	118.095	23.865	55.248	0.007	0.007	0.001	2.315	7.370	1.740	0.005	0.001	0.001	1.963	0.119	0.095
Bacterial population (× 10 ⁴ /g soil)	0.087	0.001	2.854	0.688	0.251	0.010	0.004	0.001	0.003	0.002	0.014	0.005	0.002	0.000	0.002	0.030	0.011
Fungal population (× 10 ⁴ /g soil)	0.175	0.295	44.009	19.834	3.429	0.001	0.001	0.001	0.261	0.041	0.034	0.004	0.002	0.002	0.091	0.060	0.087
G. Soil fertility status at 30-60 cm soil depth after harvest of fruit																	
pH	0.091	0.035	0.272	0.030	0.048	0.002	0.013	0.001	0.090	0.085	0.150	0.037	0.006	0.014	0.062	0.042	0.042
EC (dSm ⁻¹)	0.103	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.001	0.000	0.002	0.001	0.036	0.000
Organic carbon (%)	0.002	0.000	0.009	0.058	0.003	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000
Available N (Kg/ha)	3.951	6.700	169.525	178.400	8.587	6.036	1.370	0.007	0.773	0.120	0.003	0.354	0.057	0.003	0.076	1.360	7.782
Available P ₂ O ₅ (Kg/ha)	28.484	0.564	2.533	0.744	0.101	0.041	0.010	0.001	0.001	0.000	0.002	0.001	0.000	0.001	0.000	9.495	0.274
Available K ₂ O (Kg/ha)	92.528	2.220	0.278	0.439	0.062	0.027	0.020	0.002	0.002	0.001	0.000	0.001	0.001	0.003	0.000	30.843	12.004

<i>Azotobacter</i> population ($\times 10^4$ /g soil)	0.209	0.090	1.256	1.315	2.288	0.011	0.006	0.003	0.047	0.050	0.052	0.014	0.012	0.005	0.016	0.080	0.048
Bacterial population ($\times 10^4$ /g soil)	0.011	0.008	2.859	0.481	0.072	0.000	0.000	0.000	0.007	0.001	0.007	0.000	0.000	0.000	0.003	0.004	0.002
Fungal population ($\times 10^4$ /g soil)	0.154	0.066	7.268	6.432	0.936	0.000	0.000	0.001	0.034	0.004	0.003	0.001	0.000	0.002	0.007	0.052	0.045
H. Soil fertility status at 60-90 cm soil depth after harvest of fruit																	
pH	2.115	1.923	0.044	0.034	0.067	0.010	0.002	0.000	0.049	0.015	0.072	0.003	0.000	0.004	0.064	0.707	0.091
EC (dSm ⁻¹)	0.357	0.000	0.004	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.003	0.001	0.000	0.001	0.119	0.000
Organic carbon (%)	0.001	0.000	0.010	0.029	0.004	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Available N (Kg/ha)	19.133	2.303	92.879	44.349	3.189	0.072	0.619	0.033	1.097	0.027	0.040	0.029	0.034	0.036	0.011	6.388	6.803
Available P ₂ O ₅ (Kg/ha)	2.828	0.034	1.297	0.487	0.061	0.144	0.012	0.005	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.943	0.123
Available K ₂ O (Kg/ha)	12.558	3.521	0.177	0.289	0.026	0.002	0.009	0.000	0.003	0.000	0.001	0.001	0.000	0.001	0.000	4.186	8.009
<i>Azotobacter</i> population ($\times 10^4$ /g soil)	0.070	0.007	0.018	0.005	0.001	0.004	0.009	0.005	0.004	0.009	0.006	0.006	0.009	0.009	0.011	0.031	0.002
Bacterial population ($\times 10^4$ /g soil)	0.003	0.006	0.652	0.092	0.012	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.002
Fungal population ($\times 10^4$ /g soil)	0.062	0.019	1.836	0.141	0.041	0.001	0.000	0.000	0.027	0.020	0.008	0.001	0.002	0.000	0.024	0.021	0.007

Note

Y=Year, N=Nitrogen, V=Vermicompost, A= *Azotobacter*