

INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH, YIELD AND FRUIT QUALITY OF APPLE CV. RED DELICIOUS

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ABSTRACT

Apple is main table fruit of temperate region. It is rich in minerals, vitamins and antioxidants, those protect from several disease. An investigation was therefore undertaken to increase the production and quality of apple with suitable nutrient management. The experiment was laid out in various combinations of inorganic fertilizers (urea, SSP and MOP), FYM and vermicompost. Among all the treatments, treatment T₄ [60% inorganic fertilizers + 40% organic matter (vermicompost)] performed best where highest annual shoot growth (64.07 cm), tree height increment (0.55 cm), tree volume (23.54 m³), fruit yield (72.40 kg/ tree), fruit weight (229.42 g), fruit length (8.39 cm), fruit breadth (8.14 cm), fruit volume (290.89 cm³), total soluble solids (13.04 °B), reducing sugars (5.76 %), non reducing sugars (4.10 %) and total sugars (10.08 %) were observed. Present investigation revealed that the combination of organic manures along with inorganic fertilizers was found effective in improving the yield, fruit quality and soil health of apple orchard.

INTRODUCTION

Apple (*Malus x domestica* Borkh.) is one of the most important temperate fruit crops of North-Western Himalayan region in India. It belongs to family Rosaceae. It is liked throughout the world by all the people due to its pleasant taste and nutritional value. Uttarakhand is one of the important states for growing apple after Jammu and Kashmir and Himachal Pradesh. Apple is one of the leading fruits which are being grown in temperate region of the world. Incorporation of organic manures is a common practice to improve the yield of apple. If proper care is taken in nutrient management by using organic manures and inorganic fertilizers, the proper growth and yield of apple trees is assured. Some earlier research work on integrated nutrient management in other horticultural crops like carrot (Patil *et al.*, 2015), bittergourd (Thriveni *et al.*, 2015), garlic (Damse *et al.*, 2014), pomegranate (Dutta *et al.*, 2014) and apple (Milosevic and Milosevic, 2009) shows positive results. The continuous use of chemical fertilizers has degraded the soil health in terms of fertility and has also caused soil pollution. The reduction in soil fertility has resulted in low productivity of the crop. Besides, the increasing cost of fertilizers and their negative effect on soil health has led to intensified attempts to the use of organic matter along with inorganic fertilizers. Considering the above facts, an attempt was made to find out the response of apple trees in terms of growth and yield to integrated nutrient management.

MATERIALS AND METHODS

A field trial was conducted at Fruit Orchard Department of Fruit Science, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand during 2014-15. The experiment was laid out in randomized complete block design with seven treatments and three replications. For the experiment randomly healthy fifteen year old twenty one trees were selected from apple orchard situated at Vice Chancellor's residence of Bharsar. The treatments were as follows: T₁: 75% inorganic fertilizers + 25% organic manures (FYM), T₂: 75% inorganic fertilizers + 25% organic manures (vermicompost), T₃: 60% inorganic fertilizers + 40% organic manures (FYM), T₄: 60% inorganic fertilizers + 40% organic manures (vermicompost), T₅: 50% inorganic fertilizers + 50% organic manures (FYM), T₆: 50% inorganic fertilizers + 50% organic manures (vermicompost) and T₇ (Control- 700g N + 250g P + 700g K + 40 kg FYM). These fertilizers were applied in different doses by calculating the amount of N, P and K supplied by them to fulfill the requirement of the recommended doses. The required quantity of inorganic fertilizers (full dose of P₂O₅ and K₂O) were applied during January along with FYM and vermicompost by broadcasting under the spread of trees, 30 cm away from the trunk and were mixed with soil. The nitrogen was applied in split doses, half dose during spring before flowering and remaining half dose was applied one month after first application. Data on the annual shoot growth, tree height increment were recorded

in centimeters. The tree volume was calculated by measuring tree height and spread and using the formula given by Westwood (1978) and expressed in cubic meter (m³). The average fruit weight and size of ten fruits were taken to find out the fruit weight, fruit length and fruit breadth. The fruit volume was determined as per the formula suggested by Westwood (1993) while the TSS and sugars were calculated according to the method AOAC (1980).

RESULTS AND DISCUSSION

The results of the present investigation (Table 1) revealed that INM increased the growth parameters of apple trees. The maximum tree height increment (0.55cm) and annual shoot growth (64.07cm) were observed with the application of T₄ - 60% inorganic fertilizers + 40% organic manures (vermicompost) while the maximum tree volume (23.54 m³) were observed with T₆ - 50% inorganic fertilizers + 50% organic manures (vermicompost). Similar results were obtained by Verma and Chauhan (2013) who reported maximum vegetative growth in apple with the application of IFFCO 12:32:16 mixture + urea + MOP + lime + FYM. The increase in tree height and tree growth might be due to improvement of physical properties of soil, higher nutrient uptake and increased activity of microorganisms which were manifested in the form of enhanced growth and higher carbohydrates production (Kumar *et al.*, 2008 and Hassan *et al.*, 2001).

The highest fruit yield (72.40 kg/tree) as presented in Table 1 was recorded with the application of 60% inorganic fertilizers + 40% organic fertilizers (vermicompost). These findings indicate that integrated application of inorganic fertilizers, FYM and vermicompost was successful in maintaining higher levels of apple productivity. Singh *et al.* (2013) observed highest fruit yield of apple with 50% P through bone meal + 50 % P

through FYM and remaining N & K through urea and MOP which showed an increase of 19.44% over recommended dose of nutrients. This might be due to regular availability of nutrients through integrated use of organic and inorganic nutrient resource (Bodake *et al.*, 2007). Kumar *et al.* (2015) recorded the maximum nut yield with 40 t/ha FYM which might be due to continuous supply of optimum nutrient as per the phenological stages of nut growth and kernel filling in almond. The higher uptake and accumulation of nutrients in the tissues and fruits of apple with recommended dose of NPK might have occurred due to stimulation of the rates of various physiological and metabolic processes resulting in better fruit yield of apple. These results are in accordance with the findings of Treder (2007). Sangeeta *et al.* (2014) reported inorganic fertilizers worked better when applied with organic manures under integrated nutrient management comparatively full dose of chemical fertilizers as they found highest curd yield of cauliflower (252.48 q/ha) with application of ½ N: P: K + FYM@5t/ha + poultry manure@2t/ha + *Azospirillum* which was at par with ½ N: P: K + FYM@5t/ha + vermicompost @ 2t/ha + *Azospirillum*.

The quality parameters of apple fruit were markedly improved by integrated application of inorganic fertilizers, FYM and vermicompost during the period of study (Table 2 and 3). The maximum fruit weight (229.42 g), fruit length (8.39 cm), fruit breadth (8.14 cm) and fruit volume (290.89 cm³), total soluble solids (13.04°B), total sugars (10.08 %), reducing sugars (5.76 %) and non reducing sugars (4.10 %) were recorded with the application of T₄: 60% inorganic fertilizers + 40% organic manures (vermicompost).

The increase in quality of apple fruits by the combined application of inorganic fertilizers and organic manures might be due to accumulation of more photosynthates, nitrogen and potassium in plant system Kumar *et al.* (2008). Singh *et al.*

Table 1: Effect of integrated nutrient management on plant growth and yield of apple cv. Red Delicious

Treatments	Annual shoot growth (cm)	Tree height increment (cm)	Tree volume (m ³)	Fruit yield (kg/tree)
T ₁ [75% IF + 25 % OM (FYM)]	62.84	0.36	20.34	61.94
T ₂ [75% IF + 25 % OM (VC)]	55.85	0.28	14.06	62.94
T ₃ [60% IF + 40 % OM (FYM)]	42.27	0.17	11.01	70.70
T ₄ [60% IF + 40% OM (VC)]	64.07	0.55	15.32	72.40
T ₅ [50% IF + 50 % OM (FYM)]	47.19	0.20	11.58	53.79
T ₆ [50% IF + 50 % OM (VC)]	56.50	0.33	23.54	56.82
T ₇ (Control)	54.22	0.23	13.98	65.55
CD _(0.05)	4.90	0.17	5.00	5.13

*IF-Inorganic Fertilizer; OM-Organic Manures; FYM-Farm Yard Manure; VC-Vermicompost **T₇(Control-700g N + 250g P + 700g K + 40 kg FYM)

Table 2: Effect of integrated nutrient management on fruit quality of apple cv. Red Delicious

Treatments	Fruit weight (g)	Fruit length(cm)	Fruit breadth(cm)	Fruit volume(cm ³)
T ₁ [75% IF + 25 % OM (FYM)]	216.35	7.42	7.19	201.33
T ₂ [75% IF + 25 % OM (VC)]	212.53	7.37	7.19	200.14
T ₃ [60% IF + 40 % OM (FYM)]	225.67	8.18	7.97	272.18
T ₄ [60% IF + 40% OM (VC)]	229.42	8.39	8.14	290.89
T ₅ [50% IF + 50 % OM (FYM)]	204.27	6.47	6.02	124.83
T ₆ [50% IF + 50 % OM (VC)]	210.01	6.43	6.23	131.48
T ₇ (Control)	219.55	7.92	7.58	237.75
CD _(0.05)	9.66	0.56	0.81	52.50

*IF-Inorganic Fertilizer; OM-Organic Manures; FYM-Farm Yard Manure; VC-Vermicompost ; **T₇(Control-700g N + 250g P + 700g K + 40 kg FYM)

Table 3: Effect of integrated nutrient management on fruit quality of apple cv. Red Delicious

Treatments	TSS(ÚBrix)	Reducing sugars (%)	Total sugars(%)	Non reducing sugars (%)
T ₁ [75% IF + 25 % OM (FYM)]	12.24	5.37	9.23	3.67
T ₂ [75% IF + 25 % OM (VC)]	12.48	5.46	9.43	3.77
T ₃ [60% IF + 40 % OM(FYM)]	12.82	5.59	9.82	4.01
T ₄ [60% IF + 40% OM (VC)]	13.04	5.76	10.08	4.10
T ₅ [50% IF + 50 % OM (FYM)]	12.10	5.14	9.06	3.72
T ₆ [50% IF + 50 % OM (VC)]	12.14	5.33	9.12	3.60
T ₇ (Control)	12.91	5.67	9.89	4.01
CD _(0.05)	0.13	0.11	0.14	0.06

*IF-Inorganic Fertilizer; OM-Organic Manures; FYM-Farm Yard Manure; VC-Vermicompost; **T₇(Control-700g N + 250g P + 700g K + 40 kg FYM

(2013) observed that the highest total soluble solids, non reducing sugars and total sugars were observed with 25% P through bone meal + PSB + 50% P through FYM and remaining N and K through urea & MOP, closely followed by 25% P through bone meal + PSB + 50% P from through FYM and remaining N and K through oil cake and wood ash which may be due to better availability of nutrients from treated plant. Similar results were also obtained by Dutta *et al.* (2014) in pomegranate where 300 g nitrogen + 1 kg neem cake plant⁻¹ combination was most effective in producing highest total soluble solids, total sugar, reducing sugar, non-reducing sugar Vitamin-C content.

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