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Nutritional aspects of commercial flower crops

Binita Konwar and Lekhika Borgohain

Abstract
Plants take up essential elements from the soil through their roots and from the air (mainly consisting of nitrogen and oxygen) through their leaves. Nutrient uptake in the soil is achieved by cation exchange, wherein root hairs pump hydrogen ions (H^+) into the soil through proton pumps. The visual quality of ornamental plants is necessarily linked to an adequate balance of nutrients. Plant height, shape and coloration are qualitative aspects of ornamental species, directly influenced by mineral nutrition, among other environmental aspects. In addition to plant nutrients, some elements not considered essential, such as silicon, may provide improvements in the quality of certain species, including ornamental plants. In this sense, this paper aims to give information on the use of nutrients in some commercial flowers in order to contribute to the knowledge of the principal aspects of plant quality as relates to mineral nutrition.

Keywords: Nutrients, commercial, flowers, qualitative attributes

Introduction
Plant nutrition is defined as the supply and absorption of chemical compounds required for plant growth and metabolism. It is the process of absorption and utilization of essential elements for plant growth and reproduction.
Plants require almost 17 nutrients as a whole for its complete growth and development. They are considered as essential nutrients. For elements to be considered an essential plant nutrient, three criteria's are proposed by Arnon and Stout (1954).
1. A deficiency of the element makes it impossible for the plant to complete its life cycle.
2. The deficiency is specific for the element in question.
3. The element is directly involved in the nutrition of the plant.

Classification of essential nutrients
Of the total 17 essential nutrients 9 are considered as major nutrients and 8 are considered as minor nutrients. The classification of the nutrients are:

Table 1: Essential plant nutrients and their elemental (chemical) symbol

Nutrients supplied by air and water	Nutrients supplied by the soil system		
Non-mineral	Primary macronutrient	Secondary macronutrient	Micronutrients
Carbon – C	Nitrogen – N	Calcium – Ca	Zinc – Zn
Hydrogen – H	Phosphorus – P	Magnesium – Mg	Chlorine – Cl
Oxygen – O	Potassium – K	Sulphur – S	Boron – B
			Molybdenum – Mo
			Copper – Cu
			Iron – Fe
			Manganese – Mn
			Cobalt - Co

The adequate quantity of nutrient required differs from plant to plant and also sometimes from variety to variety depending on the soil condition.

Concept of nutrient availability
Solid phase non-adsorbed organic matter or mineral matter

Nutrient (adsorbed) solid phase	Nutrient in soil solution	Nutrient in root adsorbing surface
Nutrients distributed in the shoots	Transportation of nutrient in xylem	Nutrient in root

Though the nutrient when are applied are available to the plants yet some part of the nutrient are lost due to many factors like adsorption, leaching loss etc. rendering the plant deficient in nutrient.

Table 2: Forms in which plant nutrients are utilized by plants

Name of nutrients	Forms of nutrients used by the plants
Nitrogen (N)	NH_4^+ (Ammonium), NO_3^- (nitrate) Plant can also adsorb organic and molecular Nitrogen
Phosphorus (P)	HPO_4^{--} (Secondary Phosphate)
	$H_2PO_4^-$ (Primary Phosphate)
Potassium (K)	K^+
Calcium (Ca)	Ca^{++}
Magnesium (Mg)	Mg^{++}
Sulphur (S)	SO_2^{--} (Sulphite) and SO_4^{--} (Sulphate)
Manganese (Mn)	Mn^{++} (Manganous), Mn^{+++} (Manganic)
Molybdenum (Mo)	MoO_4^{--} (Molybdate)
Copper (Cu)	Cu^+ (Cuprous) and Cu^{++} (Cupric)
Boron (B)	Bo_3^{---}, $H_3BO_3^{--}$
Zinc (Zn)	Zn^{++}
Chlorine (Cl)	Cl^-
Iron (Fe)	Fe^{++} (Ferrous) and Fe^{+++} (Ferric)

Source: Manures and Fertilizers, P.C. Das

Nutrient stress

Nutrient stress leads to the reduction in yield of different crops. This stress can be seen by the visual symptoms and also well depicted by the following diagram where the increasing fertilizer can help in increasing the yield.

Due to the inadequate amount of nutrient available to the crops deficiency symptoms arises, the symptoms can be described in the crop plant in respect to its position in the crop plant and elements :

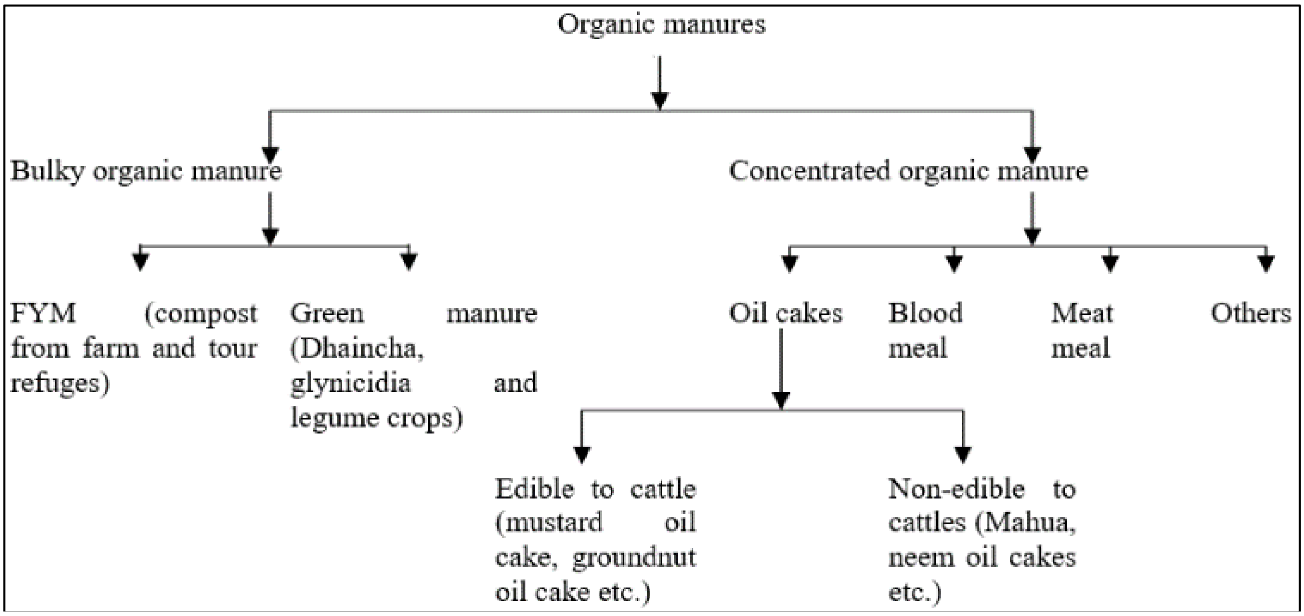
The plant nutrients are applied to the plants in different forms they are:

1. Manures
2. Fertilizers
3. Biofertilizers

Manures

They are defined as materials which are organic in origin, bulky and concentrated in the nature and capable of supplying plant nutrients and improving soil physical environment, having no definite chemical composition with low analytical value produced from animal, plant and other organic wastes and by products.

Classification of manures



Fertilizers

Fertilizers may be defined as materials having definite chemical composition with a higher analytical value and capable of supplying plant nutrients in available forms. Usually fertilizers are in organic in nature and most of them are the products of different industries except urea, $CaCN_2$, which are solid organic nitrogenous fertilizers.

Classification of fertilizers

The fertilizers are classified according to the nutrient content of individual fertilizer. They are:

1. Nitrogenous fertilizers

E.g. Ammonium sulphate (20.6-21%N), urea (46% N), sodium nitrate (16%N).

2. Phosphatic fertilizers

e.g. SSP (16-20% P_2O_5), Dicalcium phosphate (35-40% P_2O_5)

3. Potassic fertilizer

e.g. MOP (60% K_2O), sulphate of potash (52% K_2O)

4. Compound fertilizers
It is the source of more than one nutrient.
e.g. DAP (18% N 46% P_2O_5)
Amonium phosphate (16% N 20% P_2O_5)

5. Mixed fertilizers
Sources of 3 nutrients in definite grade: e.g. grade 4 (8:8:8) fertilizers.

6. Slow release nitrogenous fertilizers.
These are the fertilizers where the nutrients are release slowly to the soil due to its modify manufacturing.
e.g. MagAmp, Ureaform, IBDU, Osmocote, SCU.

Biofertilizers
Biofertilizers or microbial inoculants are defined as preparation containing life or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cell; lulolytic y-orgs used for applications to seed, soil or composting areas with the objectives of increasing the population of such beneficial y-org and accelerate certain microbial processes to augment the extent of availability of nutrient in a form which can be easily assimilated by plants.

Classification
The various types of biofertilizers are:
1. Nitrogen fixing microorganism
e.g. *Rhizobium, Azotobacter, Azospirillum*, Blue green bacteria, *Azolla*.
The fertilizer prepared with '*Rhizobium* culture' is known as 'Nitrogen' and that with bacteria 'Azotobacter' is 'Azotobacterin'.

2. Phosphate solubilizing microorganism
e.g. *Pseudomonas, Bacillus, Penicillium* and *Aspergillus* etc.
The fertilizers prepared with cultures of *Bacillus megatherium* var. *phosphaticum* is 'Phosphobacterins'.

Method of application of the plant nutrients
1. Basal application
Here the nutrients are applied as basal. Generally the manures, the starting fertilizer dose and also the split nitrogen doses are given as basal application of nutrients.

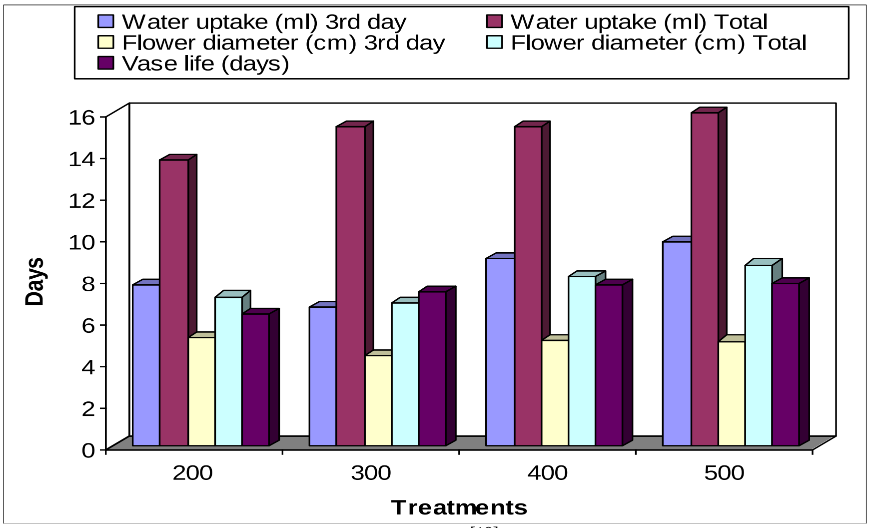
2. Foliar application
Here, the nutrients are applied as foliar formulations. The foliar formulations include the nutrients at appropriate quantity in water. It is mostly applied when it is to correct the deficiency of elements quickly is it found to be most effective.

3. Fertigation
Here, the nutrients are applied along with the irrigation water. The nutrients are mixed with the irrigation water and then they are applied to the plant in the rootzone area. Different formulations are available for fertigation.

4. Broadcasting
Here, the fertilizers are broadcasted in the foliage region of the crop. Here, there is a chance of leaf burn in case of nitrogenous fertilizers. Generally followed in field crops.

Mineral nutrition of ornamental crops
The importance of nutrition on growth, development and production of quality flowers has been well known from the beginning of understanding of its impact. Balanced nutrition is essential for the growth, development and flowering of ornamental plants. Either super critical or deficiency leads to morphological variation, which results in low productivity of quality flowers. Hence, balanced nutrition, which varies from species to species has to be standardized to get maximum income by selling larger quality produce of ornamental plants. The deficiency of nutrients even after planting as evidenced by their deficiency symptom will be corrected through foliar feeding. Now a days, ornamental plants are generally cultivated under protective cultivation with the supply of balanced nutrients in a critical way of approach through fertigation. This gives proper water management, coupled with supply of appropriate nutrients for the benefit of the plant besides avoiding mineral pollution of the soil.

Effect of nutrition on different crops
1. Rose
Rose is considered to be the No. 1 cut flower in the world flower market. Different experiments were conducted regarding the nutritional requirement of rose. Nutrition as direct effect on Gurav *et al*. (2005) [12] conducted an experiment in NARP, Pune to study the effect of various nutritional levels on yield and quality of rose cv. First Red.
Their were nine treatments and three replications. The treatments were N_1P_1K = 200:100:200 ppm/plant/week, N_1P_2K = 200:200:200 ppm/plant/week, N_1P_3K = 200:300:200 ppm/plant/week, N_2P_1K = 300:100:200 ppm/plant/week, N_2P_2K = 300:200:200 ppm/plant/week, N_2P_3K = 300:300:200 ppm/plant/week, N_3P_1K = 400:100:200 ppm/plant/week, N_3P_2K = 400:200:200 ppm/plant/week, N_3P_3K = 400:300:200 ppm/plant/week.
The treatment N_3P_2K to be the best treatment and may be due to the higher dose of nitrogen which showed significant increase in plant height and also the phosphorus with the optimal dose had the positive interaction effect on the growth and flowering increasing the plant height, no. of flowers/plant/year, no. of flowering shoot/plant, flower bud size (cm), stem length of cut flowers.
Nitrogen fertilization also have direct effect on the vase life of cut flowers and it has been reported by many workers.
Battacharjee and Vidhya Sankar (2000) [18] conducted an experiment in IARI, New Delhi on the topic "Effect of nitrogen on growth flowering and post harvest life of rose cv. Arjun".



Source: Battacharjee and Vidhya Sankar (2000) [18]

Fig 1: Effect of nitrogen on post harvest life and quality of 'Arjun' roses

Here it is clear that the longest post harvest life of cut roses was recorded with the nitrogen treatment of 500 kg/ha/yr. It may be due to the increase in nitrogen dose, the fresh weight of the stems and flowers increase which means that there is more accumulation of photosynthates that results in more water uptake and thus prolonging the vase life of the crop.

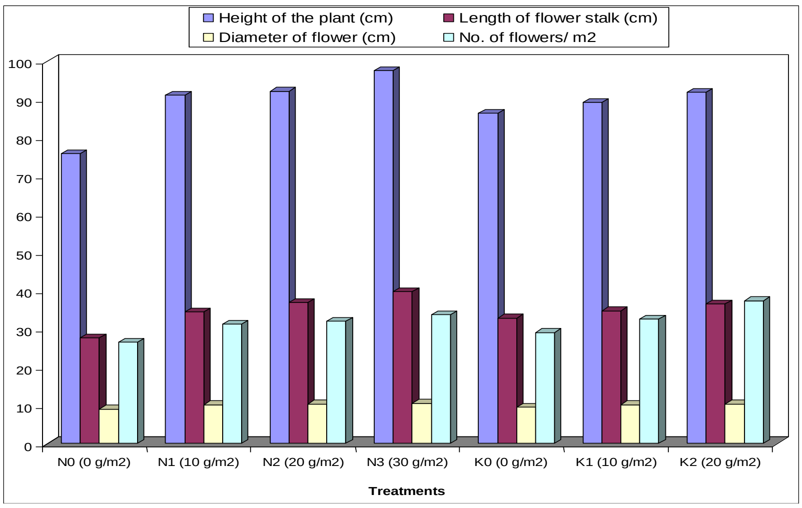
It is also seen that the manures and biofertilizers have direct effect on the growth and flowering in rose.

Singh *et al*. (2006) [16] conducted an experiment in BHU, Varanasi on the topic "Response of manures and bio-fertilizers on growth and flowering in rose" with treatments including one control. The treatments were T_1 = Control; T_2 = NPK 50, 40 and 30 g/m^2; T_3 = FYM 4 kg/m^2 + NPK 25, 20, 15 g/m^2; T_4 = Mushroom spent (MS) 4 kg/m^2 + NPK 25, 20, 15 g/m^2; T_5 = Poultry manure (PM) 4 kg/m^2 + NPK 25, 20, 15 g/m^2; T_6 = T_3 + Azotobacter; T_7 = T_3 + VAM, T_8 = T_4 + Azotobacter; T_9 = T_4 + VAM; T_{10} = T_5 + Azotobacter; T_{11} = T_5 + VAM. Here T_{10} and T_{11} are significant to all other treatments and T_{11} had the best results. This may be due to the poultry manure which improved the physical condition of the soil and increased the absorption are of nutrient and water. VAM might have increased the last release of nutrients and increased level of especially micronutrient and more absorption are by VAM. These factors increased plant growth and leaf area by which more photosynthates produced and resulted in production of more flowers than other organic and inorganic treatment.

2. Chrysanthemum

Chrysanthemum is one of the top five cut flower in the international flower trade market and has tremendous scope for earning foreign exchange from this crop. Therefore, proper care is important for the proper growth and flowering of the crop and as thus it requires proper nutrition.

Barman and Pal (1999) conducted an experiment on the effect of application of nitrogen and potassium in different spacing on chrysanthemum cv. Chandrama. With the following treatment along with common application of FYM @ 2 kg/m^2 and P_2O_5 @ 10 g/m^2.



Source: Barman and Pal (1999)

Fig 2: Effect of application of nitrogen and potassium in different spacing on chrysanthemum cv Chandrama

Here it is clear that application of N_3 i.e. 30g/m^2 of Nitrogen is found to be best for height of the plant, length of the flower stalk, flower diameter and no. of flower/m^2 same is the case with the potassium application @ 20 g/m^2. This shows that nitrogen and potassium is the most significant element in the growth and flowering as N increases the metabolites and K increase the growth.

3. Carnation

Carnation (*Dianthus carypohyllus*) is an excellent cut flower crop and is considered as one of the top five cut flowers in the international market.

Organic manure and biofertilizers have direct effect on the nutrition and growth and flowering in carnation and it was well given by Bhalla *et al*. (2007) [4].

4. Orchids

Orchids are a group of plants that are popular among the people because of its diversity in shape, size and colour. They have a longer vase life compared to the other flower crops. They are known for their long lasting and bewitchingly beautiful flowers, which fetch a very high price in the international market. Orchids are similar to the other non-orchidaceous plants in their requirements for minerals, except that they generally takes a longer time to show mineral deficiency.

Foliar application of nitrogen have direct effect on flowering in cymbidium hybrid and it was well established by Naik and Barman (2006) [13].

Naik and Barman (2006) [13] conducted an experiment with 13 treatments on cymbidium hybrid 'show girl' to see the effect of foliar application of nitrogen on flowering.

Table 3: Response of foliar application of nitrogen on flowering in Cymbidium hybrid cv Show Girl

Treatments	Spike length (cm)	Rachis length (cm)	No. of flowers/ spike	No. of spikes/ clump
$N_5 : K_5$ (0.1%)	27.50	20.25	3.25	1.25
$N_5 : K_5$ (0.2%)	28.35	21.30	3.30	1.50
$N_5 : P_5 : K_5$ (0.3%)	30.15	23.75	3.45	1.65
$N_5 : P_5 : K_5$ (0.1%)	30.75	23.90	4.10	1.00
$N_{10} : P_5 : K_5$ (0.2%)	32.60	24.15	4.25	1.15
$N_{10} : P_5 : K_5$ (0.3%)	35.00	26.40	4.45	1.25
$N_{15} : P_5 : K_5$ (0.1%)	33.67	22.15	4.45	1.75
$N_{15} : P_5 : K_5$ (0.2%)	38.25	27.30	4.81	1.90
$N_{15} : P_5 : K_5$ (0.3%)	39.70	27.90	5.50	2.75
$N_{20} : P_5 : K_5$ (0.1%)	38.10	27.45	5.00	1.25
$N_{20} : P_5 : K_5$ (0.2%)	39.35	28.15	5.10	1.95
$N_{20} : P_5 : K_5$ (0.3%)	45.00	30.25	4.80	2.00
Control (Distilled water	20.25	15.15	1.00	1.00

Source: Naik and Barman (2006) [13]

N_{10} = 10g of Ammonium nitrate

N_{15} = 15 g of Ammonium nitrate

N_{20}=20 g of Ammonium nitrate

P_5 = 5 g of Ammonium dehydrogenate phosphate

K_5 = 5g of potassium nitrate

From Table 3 it is clear that the vegetative growth increases with increase in nitrogen is the spike length and the rachis length but the number of flowers and number of spikes increase to a extent and then decreases. Thus it is seen that concentration of nitrogen is more critical than phosphorus or potassium in promoting growth and flowering.

5. Anthurium

Anthurium (*Anthurium andreanum*) flowers are popular due to its bold effect and long pasting qualities. The popularity of growing anthurium as a cut flower has risen tremendously in the past few years and now it has become an important cash crop.

Greater scope for integration of chemical fertilizers with organic supplements obtained through biological sources improve the flower yield in Anthurium and was reported by Waheeduzzama *et al*. (2007) [19].

Waheeduzzama (2007) [19] conducted an experiment on integrated nutrient management practice to improve the flower yield in anthurium. He conducted the experiment with 11 treatments. The treatments were:

T_1 = Vermicompost 100 g/pot + 50% of recommended dose of fertilizers (RDF)

T_2 = Neem cake 100 g/pot + 50% RDF

T_3 = FYM 200 g/pot+ 50% RDF

T_4 = DCC 100 g/pot + 50% RDF

T_5 = Manchurian tea 100% + 50% RDF

T_6 = Manchurian tea 50% + 50% RDF

T_7 = Panchagavya 2% drenching + 50% RDF

T_8 = Panchagavya 2% foliar spray + 50% RDF

T_9 = Panchagavya 4% drenching + 50% RDF

T_{10} = Panchagavya 4% foliar spray + 50% RDF

T_{11} = Control – NPK @ 30:10:10 at 0.25% (recommended dose of fertilizers)

Table 4: Effect of INM practices on vegetative growth, flowering and root parameters of anthurium cv. Meringue

Treatments	Plant height(cm)	No. of leaves/plant	Days to first flowering	No. of flowers/plant	No. of suckers/plant
T_1	25.40	5.70	216.20	4.80	2.70
T_2	26.60	5.90	218.40	4.34	2.50
T_3	28.40	5.10	224.10	3.80	4.00
T_4	31.40	5.20	228.40	3.92	3.50
T_5	30.20	5.80	227.00	3.10	3.70
T_6	23.90	3.98	250.20	2.50	2.60
T_7	25.30	6.00	240.10	1.83	3.00
T_8	29.40	4.90	212.00	4.82	2.40
T_9	25.10	4.70	215.50	2.20	4.00
T_{10}	32.40	6.20	206.50	5.90	4.20
T_{11}	31.80	5.90	208.10	5.60	4.02

Mean	28.17	5.38	222.40	3.89	3.329

Source: Waheeduzzama (2007) [19]

The table reveals that the growth and yield attributes were highest in the plants T_{10}. This might be due to quick absorption of nitrogen which was received by plants through panchagavya and inorganic fertilizers and easy transfer of nutrients to the plants through foliar spray and the highest N_2 supply would have promoted protein synthesis from reserved carbohydrate leading to the production of more number of leaves. This treatment also resulted in earliness in flowering (206.50 days), highest number of flowers/ pH (5.90) and number of suckers/ plant (4.20). This might be due to sustained availability of nitrogen throughout the growing phase and also due to enhanced carbohydrate syntheses and effective translocation of photosynthates to the developing sink. The proportion and activity of beneficial microbes would be at the higher rate in panchagavya which helps in synthesis of growth promoting subs that might have increased the yield of flowers.

6. Gerbera (*Gerbera jamesonii* Bolus)

As a commercial cut flower in international flower trade, gerbera is now gaining acceptability. It is a profit maximizing proposition to grow quality gerbera throughout the year. Now, it is the sixth ranking cut flower in export market. The quality of a flower is the only criteria for getting an entrance in the world market and the quality again depends upon several factors including management operations. Fertilization is one of the factors to improve the quality.

NPK has direct effect on the growth and flowering of gerbera and it was well established by Terangpi and Paswan (2008) in an experiment conducted at AAU, Jorhat.

Table 5: Effect of different combinations of NPK on the growth and flowering of Gerbera

Treatments	Plant height (cm)	No. of sucker/ plant (nos.)	No. of flowers/ plant (nos.)	Size of flowers (cm)	Shelf life (days)	Vase life (days)
$T_1 = N_1P_1K_1$	44.30	20.47	40.65	10.77	23.16	9.19
$T_2 = N_1P_1K_2$	39.96	21.75	54.80	11.80	24.26	9.57
$T_3 = N_1P_1K_3$	40.78	22.46	47.99	11.31	23.69	9.87
$T_4 = N_1P_2K_1$	42.94	23.37	58.97	11.58	23.95	9.40
$T_5 = N_1P_2K_2$	42.38	23.13	46.90	11.04	25.73	10.03
$T_6 = N_1P_2K_3$	42.82	20.43	53.37	11.12	24.23	10.21
$T_7 = N_1P_3K_1$	41.85	21.13	51.47	11.50	22.31	10.04
$T_8 = N_1P_3K_2$	42.39	20.18	37.40	10.90	23.19	11.53
$T_9 = N_1P_3K_3$	38.61	22.13	47.50	11.19	24.92	11.31
$T_{10} = N_2P_1K_1$	39.47	20.03	45.47	11.08	24.62	10.20
$T_{11} = N_2P_1K_2$	41.15	21.11	41.14	11.30	22.31	11.02
$T_{12} = N_2P_1K_3$	36.33	26.13	39.47	12.13	23.64	11.04
$T_{13} = N_2P_2K_1$	39.17	24.23	41.02	11.22	22.18	10.06
$T_{14} = N_2P_2K_2$	40.03	19.67	37.58	11.69	23.50	11.37
$T_{15} = N_2P_2K_3$	44.22	23.50	43.04	11.30	24.30	12.76
$T_{16} = N_2P_3K_1$	42.17	22.08	40.40	11.25	23.01	11.51
$T_{17} = N_2P_3K_2$	40.57	21.30	47.38	10.88	24.71	11.54
$T_{18} = N_2P_3K_3$	42.07	22.07	44.45	11.27	24.11	12.20
$T_{19} = N_3P_1K_1$	42.72	26.97	61.56	11.57	24.72	12.61
$T_{20} = N_3P_1K_2$	45.69	30.40	67.01	12.15	26.35	13.50
$T_{21} = N_3P_1K_3$	41.49	20.10	44.40	10.74	25.54	12.42
$T_{22} = N_3P_2K_1$	40.15	17.99	38.37	11.20	23.87	12.30
$T_{23} = N_3P_2K_2$	43.41	24.01	55.10	11.31	23.07	12.56
$T_{24} = N_3P_2K_3$	40.55	26.30	60.30	11.05	24.30	12.06
$T_{25} = N_3P_3K_1$	41.21	22.03	46.51	11.32	22.57	11.42
$T_{26} = N_3P_3K_2$	43.33	22.07	51.33	11.10	23.58	11.17
$T_{27} = N_3P_3K_3$	39.43	22.13	41.02	10.39	23.86	11.06
T_{28} = Control / zero level of NPK	30.14	17.50	32.20	9.48	20.04	6.80
CD at 5%	2.20	0.27	0.21	0.23	0.24	0.28

Source: Terangpi (2002) [17]

Here,

$N_1 = 10g\ N/m^2$ $P_1 = 10g\ P_2O_5/m^2$ $K_1 = 10g\ K_2O/m^2$

$N_2 = 20g\ N/m^2$ $P_2 = 20g\ P_2O_5/m^2$ $K_2 = 20g\ K_2O/m^2$

$N_3 = 30g\ N/m^2$ $P_3 = 30g\ P_2O_5/m^2$ $K_3 = 30g\ K_2O/m^2$

From the above table the treatment T_{20} with application of 30 g N, 10 g P_2O_5 and 20 g K_2O is found to be the most effective. This is because nitrogen increases the vegetative growth and thus increases the plant height and also the number of suckers/ plant. Nitrogen, phosphorus and potassium also might had the effect on floral characters as because the flower number was higher with 30 N/m^2 and 10g P_2O_5/ml, this may be due to the lack of response of floral characters to P and also at P has a negative interaction with Zn and Fe this may result in number of flowers. In case of potassium the dose of 20 g K_2O/m^2 produced highest flowers and this may be due to the fact that K is associated with carbohydrate metabolism and translocation of starch.

The shelf life and vase life of the flower crop was also found to be bet with T_{20}. This may be because of proper utilization of P and K and also due to higher amount of reserve food material content in the flower, better phosphorylation in plants and better carbohydrate metabolism and adjustment of water relation in the crop. Micronutrients also have a marked effect on the flower production in Gerbera and it was well established by an experiment conducted by Muthumanickam *et al*. (1999).

Muthumanickman *et al*. (1999) conducted an experiment on the "Effect of micronutrients on flower production in gerbera" with 8 treatments.

Table 6: Effect of micronutrient on flower production in Gerbera

Treatments	Yield/ plant (nos.)	Stalk length (cm)	Flower diameter (cm)	Plant height (cm)	Vase life (days)
$MnSO_4$ (0.2% spray)	41.00	46.20	10.10	59.80	5.00
$FeSO_4$ (0.2% spray)	42.00	47.43	10.26	61.40	5.00
$ZnSO_4$ (0.2% spray)	42.66	50.26	10.53	63.60	5.30
$MnSO_4$ + $FeSO_4$ (0.2% spray each)	43.00	52.10	10.80	65.70	5.60
$MnSO_4$ + $ZnSO_4$ (0.2% spray each)	45.00	55.46	11.23	71.80	6.30
$FeSO_4$ + $ZnSO_4$ (0.2% spray each)	44.33	54.20	10.93	68.60	6.00
$MnSO_4$ + $ZnSO_4$ + $FeSO_4$ (0.2% spray each)	46.66	58.40	11.80	76.40	7.00
Control	28.33	36.16	9.86	51.20	4.00
CD (0.05)	0.618	1.082	0.062	3.420	0.062

Source: Muthumanickman *et al*. (1999)

From the above table it is clear that spraying of $MnSO_4$ + $ZnSO_4$ + $FeSO_4$ @ 0.2% yield/plant, stalk length, flower diameter, plant height and vase life. As because with the increasing amount of the micronutrient levels in leaves helped the plants to produce higher number of flowers by involving the photosynthesis, breakdown of IAA, auxins and protein synthesis.

7. Gladiolus

Gladiolus is an important ornamental bulbous plant grown for cut flower and bedding purposes. Nutrition is one of the important aspects in increasing the flower yield and quality of gladiolus spikes.

Sharma *et al*. (2007) [15] studied the response of N, P and K vegetative growth, flowering and corm production in gladiolus under mango orchard in Raipur and found significant results. The experiment was conducted with 6 treatments- $N_0P_0K_0$, $N_{10}P_5K_5$, $N_{20}P_{10}K_{10}$, $N_{30}P_{15}K_{15}$, $N_{40}P_{20}K_{20}$ and $N_{50}P_{25}K_{25}$.

N_0 = 0 level of nitrogen P_0 = 0 level of P_2O_5
N_{10} = 10 g/m^2 nitrogen P_5 = 5 g/m^2 P_2O_5
N_{20} = 20 g/m^2 nitrogen P_{10} = 10 g/m^2 P_2O_5
N_{30} = 30 g/m^2 nitrogen P_{15} = 15 g/m^2 P_2O_5
N_{40} = 40 g/m^2 nitrogen P_{20} = 20 g/m^2 P_2O_5
N_{50} = 50 g/m^2 nitrogen P_{25} = 25 g/m^2 P_2O_5
K_0 = 0 level of K_2O
K_5 = 5 g/m^2 K_2O
K_{10} = 10 g/m^2 K_2O
K_{15} = 15 g/m^2 K_2O
K_{20} = 20 g/m^2 K_2O
K_{25} = 25 g/m^2 K_2O
(Where N, P and K were applied through CAN, SSP and MOP)

Here the treatment $N_{50}K_{25}$ and $N_{40}P_{20}K_{20}$ were found to be the best with par to each other. The reason behind it may be as the vegetative growth is very much depended on the nitrogen. Therefore with the increase in the nitrogen dose the meristematic activities, cell division, cell number and cell enlargement of the plant was more (Kumar and Misra, 2003). Also the phosphorus promotes root development and enhances uptake of nitrogen. It stimulates the root system through efficient translocation of certain growth stimulating compounds formed in plants to the roots, which might have enhanced the absorption of nutrients thus resulting in a vigorous growth. Plants supplied with higher dose of phosphorus along with nitrogen might have continuously maintained and enhanced the vegetative growth.

The application of $N_{40}P_{20}K_{20}$ g/m^2 is proved good for the floral characters, this may be due to the presence of Ca in CAN and S in SSP, which might have participated in higher protein synthesis and thus partitioning of nutrients towards the developing spikes.

Bhalla *et al*. (2006) [3] reported the effect of biofertilizers and biostimulants on growth and flowering in gladiolus at solan with cv. Red Beauty.

The experiment was conducted with 18 treatments combination. The treatments were:

T_1 = Common basal dose
T_2 = Common basal dose + 2% Panchagavya
T_3 = Common basal dose + 4% Panchagavya
T_4 = Common basal dose + 6% Panchagavya
T_5 = Common basal dose + 2% Manchurian Mushroom Tea
T_6 = Common basal dose + 2% Manchurian Mushroom Tea + 2% Panchagavya
T_7 = Common basal dose + 2% Manchurian Mushroom Tea + 4% Panchagavya
T_8 = Common basal dose + 2% Manchurian Mushroom Tea + 6% Panchagavya
T_9 = Common basal dose + 4% Manchurian Mushroom Tea
T_{10} = Common basal dose + 4% Manchurian Mushroom Tea + 2% Panchagavya
T_{11} = Common basal dose + 4% Manchurian Mushroom Tea + 4% Panchagavya
T_{12} = Common basal dose + 4% Manchurian Mushroom Tea + 6% Panchagavya
T_{13} = Common basal dose + 6% Manchurian Mushroom Tea
T_{14} = Common basal dose + 6% Manchurian Mushroom Tea + 2% Panchagavya
T_{15} = Common basal dose + 6% Manchurian Mushroom Tea + 4% Panchagavya
T_{16} = Common basal dose + 6% Manchurian Mushroom Tea + 6% Panchagavya
T_{17} = Common basal dose + required fertilizer dose
T_{18} = General media + required fertilizer dose

Manchurian mushroom tea = 4 table spoons of ordinary tea was added in 2.5 litre of water and was boiled for five minute. After filtering, the solution in a glass jar, 300 g of pure sugar was added to it to make the concentration of 12.5 per cent. The solution was cooled to lukewarm stage and 30 g of starter Manchurian yeast culture (*Kombuncha* sp.) was added to it. The mouth of jar was covered with clean muslin cloth and was kept at room temperature in a well aerated place. After 10 day, when the solution started emitting foul, smell solution was filtered in another clean glass jar.

Panchagavya fresh mix = Panchagavya fresh cow dung (5 kg), cow urine (3 l), cow milk (2 l), cow curd (1 l), cow ghee (100 g), sugarcane juice (3 l), tender coconut juice (3 l) and ripe banana (12) were mixed in an earthen pot which was covered with muslin cloth. The pot was kept in shade for two month and contents were stirred daily. This solution was then filtered in a glass jar and was used subsequently.

Common basal dose = Common basal dose consisted of FYM @ 2 kg/m^2 / year, decomposed coir compost @ 200 g/m^2 / year and Trichoderma @ 20 g/m^2/year (this was applied after mixing with above mentioned FYM dose, slightly moistened and covered with polythene sheet for a week). Biofertilizers namely VAM, *Azospirillum*, PSB @ 2 g each/plant were added 21 days after planting.

Table 7: Effect of biofertilizers and biostimulants on growth and flowering of gladiolus cv. Red Beauty

Treatment	Plant height (cm)	Flowering duration (day)	Spike length (cm)	Number of florets / spike	Floret diam. (cm)	Vase life (day)
T_1	90.39	14.27	56.7	12.77	9.58	6.27
T_2	88.64	12.43	52.2	12.10	9.48	6.07
T_3	90.94	12.80	55.3	13.53	9.87	7.80
T_4	92.88	14.70	56.7	13.40	9.22	7.20
T_5	95.66	13.10	57.7	12.33	10.05	7.07
T_6	95.74	12.33	56.9	12.53	9.69	7.13
T_7	95.10	12.67	56.6	13.07	10.24	7.20
T_8	101.00	11.60	60.8	13.27	10.18	7.33
T_9	93.50	11.53	56.8	13.33	10.26	8.20
T_{10}	93.79	14.67	56.3	12.77	9.74	7.87
T_{11}	99.74	11.83	61.4	13.33	9.87	8.07
T_{12}	102.80	13.95	61.9	13.37	10.25	7.20
T_{13}	90.96	12.27	55.2	11.74	10.16	7.53
T_{14}	91.57	12.87	56.8	12.87	10.37	7.80
T_{15}	94.14	13.37	58.1	12.70	9.54	7.67
T_{16}	91.31	13.50	52.1	12.07	10.67	7.60
T_{17}	82.37	12.00	49.9	10.47	9.36	7.47
T_{18}	87.90	12.17	52.4	12.37	9.75	7.27
CD (P=0.05)	9.77	0.93	NS	1.56	0.63	0.62

Source: Bhalla *et al*. (2006) [3]

Table reveals T_{12} to be the best at par with T_{16}. These were sprayed on the foliage, the absorption of nutrients was on higher side, thus encouraging quick growth and increased plant height as well as other growth attributes.

8. Tuberose

Tuberose (*Polianthes tuberose* Linn.) is an important bulbous flowering perennial ornamental plant. It has gained considerable popularity and widely grown for aesthetic, aromatic and commercial purposes. The flower spikes are excellent as cut flower for table decoration. The natural flower oil of tuberose remains even today as one of the most expensive perfume's raw material.

The optimum supply of plant nutrients is an important factor in growth and flowering in tuberose.

Patel *et al*. (2006) [14] conducted an experiment on the effect of nitrogen, phosphorus on the flowering in tuberose cv. Single.

Table 8: Effect of nitrogen, phosphorus and spacing on growth and spikes flowering in tuberose cv. Single

Treatments	Plant height (cm)	Number of leaves/ plant	Number of days to flowering	Spike yield/ ha (no.)	Spike length (cm)	Rachis length (cm)	Number of florets/ spike	Number of spikes/ plant	Bulb yield (t/ha)
Nitrogen (kg/ha), N									
100	45.07	45.87	146.94	141718	94.96	25.90	32.19	1.26	29.56
200	47.52	47.09	133.34	162551	97.89	27.93	35.23	1.44	34.81
300	49.41	48.17	119.09	175583	99.80	29.54	37.14	1.56	38.93
400	51.55	49.84	109.61	197359	104.05	31.56	40.38	1.76	43.05
CD (P=0.05)	1.63	0.95	9.56	12187	2.42	1.38	1.80	0.11	1.73
Phosphorus (kg/ha), P									
100	47.61	47.23	132.45	162873	98.09	27.94	35.12	1.45	34.93
150	48.43	47.70	126.68	168017	98.83	28.73	36.32	1.50	36.55
200	49.13	48.30	122.60	177019	100.60	29.53	37.26	1.58	38.30
CD (P=0.05)	NS	0.82	NS	10553	NS	1.20	1.56	0.096	1.48

Source: Patel *et al*. (2006) [14]

The above table reveals the application of 400 kg/ha N and 200 kg/ha of P to be the best in terms of vegetative and floral characters this was because nitrogen is he major element in vegetative growth as such nitrogen application inducing earlier flowering might be attributed to higher supply of nitrogen, which results in the early completion of vegetative growth. It promotes more vegetative growth by increasing the amount of assimilates that are needed for improvement in length of spike and rachis.

Baruah *et al*. (1998) [2] conducted an experiment at AAU, Jorhat on the topic "Response of tuberose (*Polianthes*

tuberosa) with increasing dose of NPK". They conducted a experiment with seven treatments. The treatments were:
T_1 = 40:20:0 NPK/g/m^2 T_2 = 40:20:20 NPK/g/m^2
T_3 = 40:20:40 NPK/g/m^2 T_4 = 80:40:60 NPK/g/m^2
T_5 = 80:40:80 NPK/g/m^2 T_6 = 120:60:100 NPK/g/m^2
T_7 = 120:60:120 NPK/g/m^2

Table 9: Effect of NPK on growth and flowering of tuberose

Treatments	Plant height (cm)	Days to opening of flower	Length of spike (cm)	Length of rachis (cm)	Number of pairs of florets per spikes	Self life of spike	Vase life of spike	Yield of spike (g/m^2)
T_1	93.42	116.27	94.63	31.07	10.93	17.13	11.47	530.95
T_2	94.68	111.20	96.72	33.13	12.47	18.13	11.67	576.19
T_3	95.80	103.53	106.35	35.27	15.27	19.13	15.60	664.29
T_4	101.13	98.33	104.89	33.67	17.47	22.26	17.47	692.86
T_5	100.54	97.66	100.76	32.33	15.47	20.33	17.00	645.24
T_6	98.56	99.33	89.77	29.87	12.07	19.53	14.13	635.72
T_7	97.21	99.63	86.55	28.73	11.33	18.40	12.47	604.76
CD (P=0.05)	1.46	1.09	1.50	2.66	0.78	1.02	1.13	32.23

Source: Baruah *et al.* (1998) [2]

From the above data, the treatment of T_4 i.e. application of 80: 40: 60 g/m^2 of NPK is found to be best this may be because with the appropriate nitrogen the vegetative growth is optimum and the level of 60 g K/m^2 may be the optimum for production of cytokinin and promotion of flower morphogenesis resulting in increased number of florets/spike. This treatment might also be a balanced supply of NPK, promoting translocation of phytohormones resulting in early flower initiation.

9. Marigold

Marigold is an important commercial annual flower. Other than cut flower, marigold is used for beautification and also in landscape due to its variable height and colour of flowers. Maximization of flower yield with quality and extending vase life are of prime importance in the cultivation of Marigold. This can be achieved with optimum use of fertilizers.
Gavhane *et al.* (2004) [11] conducted an experiment on the effect of graded doses of fertilizers on growth, flowering quality and yield of Marigold (*Tagets erecta* L.) cv. Pusa Narengi Gainda. The experiment was conducted with four treatments. The Treatments were:
F_0 = Control
F_1 = 100 : 50 : 50 NPK/ha
F_2 = 200 : 100 : 100 NPK/ha
F_3 = 300 : 150 : 150 NPK/ha

Table 10: Effect of graded doses of fertilizers, polythene mulching and their interactions on growth, flower quality and yield of marigold var. 'Pusa Narangi Gainda'

Treatments	Plant height (cm)	No. of branches per plant	Flower diameter (cm)	Stalk length of flower (cm)	No. of flowers per plant	Yield of flower per plant (cm)	Flower yield (q/ha)
F_0	95.87	18.48	7.98	11.30	44.65	400.42	197.73
F_1	102.56	20.48	8.18	12.57	45.95	477.09	235.58
F_2	110.35	22.55	8.39	13.52	48.60	538.97	266.14
F_3	116.25	25.56	8.65	15.33	52.01	614.69	303.53
CD (5%)	0.476	9.217	0.037	0.078	0.226	2.298	1.114

Source: Gauvane (2004) [11]

The above table reveals the treatment F3 to be the best treatment this is as because with the increase in the fertilizers Nitrogen the vegetative growth increases and thus the floral attributes increases along with the optimum dose of phosphorus and potassium.

Conclusion

The effect of nutrition on the growth, yield, flowering and the quality is well known. But, due to the inadequate fertilization the quality of the produce decreases as the lower doses would result in the deficiency of the element and the higher dose would result in the toxicity resulting in adverse effect on the flower quality.
Therefore, a proper dose of fertilizers of not only the major but also the minor nutrients are very much essential to keep in the good quality of the crops. By proper understanding the optimum dose through different field trials the proper dose for a particular crop can be determined and hence a good quality produce can be obtained.

References

1. Balakrishnan V, Jawaharlal M, Kumar ST, Ganga M. Response of micronutrients on flowering, yield and xanthophyll content in African marigold (*Tagetes erecta* Linn.). J Ornamental Horticulture. 2007; 10(3):153-156.
2. Baruah N, Choudhury Talukdar M, Mahanta P. Response of tuberose (*Polianthes tuberosa*) with increasing dose of NPK. Indian Agricultural Science. 1998; 68(9):629.
3. Bhalla R, Kanwar P, Dhiman SR, Jain R. Effect of biofertilizers and biostimulants on growth and flowering in gladiolus. J Ornamental Horticulture. 2006; 9(4):248-252.
4. Bhalla R, Kumar SMH, Jain R. Effect of organic manures and biofertilizers on growth and flowering in standard carnation (*Dianthus caryophyllus* Linn.). J Ornamental Horticulture. 2007; 10(4):229-234.
5. Bose TK, Yadav LP, Pal P, Das P, Parthasarathy VA. Commercial flowers vol. I, 2nd revised edition, Naya Prokash, Calcutta-6, 2002.
6. Bose TK, Yadav LP, Pal P, Das P, Parthasarathy VA. Commercial flowers. Vol. II, 2nd revised edition, Naya Prokash, Calcutta-6, 2003.

7. Das DK. Introductory soil science. Kalyani Publishers, New Delhi, 1996, 53.
8. Das PC. Manures and fertilizers, 2006, 90-96.
9. Das PC. Manures and fertilizers. Kalyani Publishers, New Delhi, 2008, 3-6.
10. Das PC. Manures and fertilizers. Kalyani Publishers, New Delhi, 2008, 44-45.
11. Gauhane PB, Kore VN, Dixit AJ, Gondhali BV. Effect of graded doses of fertilizers and polythene mulches on growth, flower quality and yield of marigold (*Tagetes erecta* L.) cv. Pusa Narengi Gainda. J Ornamental Horticulture. 2004; 32(1):35-37.
12. Gaurav SB, Singh BR, Katwate SM, Sable RN, Kakade DS, Dhane AV. Influence of NPK nutrients on yield and quality in rose under polyhouse conditions. J Ornamental Hort. 2005; 8(3):228-229.
13. Naik SK, Barman D. Response of foliar application of nitrogen on flowering in cymbidium hybrid. J Ornamental Horticulture. 2006; 9(4):270-273.
14. Patel MM, Parmar PB, Parmar BR. Effect of nitrogen, phosphorus and spacing on growth and flowering in tuberose (*Polianthes tuberosa* Linn.) cv. Single. J Ornamental Horticulture. 2006; 9(4):286-289.
15. Sharma G, Singh P. Response of N, P and K on vegetative growth, flowering and corm production in gladiolus under mango orchard. J Ornamental Horticulture. 2007; 10(1):52-54.
16. Singh AK, Singh D, Jauhari S. Response of manures and bio-fertilizers on growth and flowering in rose. J Ornamental Horticulture. 2006; 9(4):278-281.
17. Terangpi H. Effect of different NPK combinations for growth and flowering of gerbera cv. Popular. M.Sc. (Agri.) Thesis, Assam Agricultural University, Jorhat, 2002.
18. Vidhya SM, Bhattacharjee. Effect of nitrogen on growth, flowering and post-harvest life of Rose cv. Arjun. J Ornamental Horticulture. 2000; 3(1):22-25.
19. Waheeduzzama M, Jawaharlal M, Arulmozniyan R, Indhumathi K. Integrated nutrient management practices to improve flower yield in anthurium (*Anthurium andreanum* Lind.). J Ornamental Horticulture. 2007; 10(1):42-45.