Mini Mission 1, Technical Bulletin 5

BASICS OF
ORCHID NUTRITION

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Cover Photographs
Front: Glimpses of Nutrient deficiency symptoms and their management in orchids
Back: *Cymbidium* "Sleeping Nymph"

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Foreword

Orchids grow in the most diverse climatic zones. Some flourish in continually moist, warm regions, others in regions that are warm and moist some of the time, others again in regions that are dry and hot in the daytime and moist and cool at night. Regular aeration or ventilation is extremely important for the growth of orchids in particular for their aerial roots. Their roots are exposed and receive the necessary nutrients by way of the air and rainfall through velamen. The valuable source of nutrients is rainfall, since it washes dust particles out of the air. Water flowing over the leaf surfaces would also leach mineral and organic nutrients from the leaf. The major source of nutrients however is probably the slow decomposition of organic materials accumulated in tree crotches.

As the plants need vary during the year, depending on the stage of its growth, nutrient requirement also vary. Keeping this in view the present technical bulletin has been devised to disseminate the basics of orchid nutrition. The technical bulletin highlights the essential plant nutrients, deficiency symptoms, fertilizer management and water management. The authors have put up their efforts to make the technical bulletin self explanatory, worthy and handy.

It gives me immense pleasure to bring out this bulletin on basics of orchid nutrition, which will create greater awareness among the orchid growers, extension personnel, students and researchers. I am sure that the bulletin will be useful to devise proper nutritional management to grow orchids effectively and efficiently.

(R. P. Medhi)
Director

NRC for Orchids
Pakyong, Sikkim
December, 2010

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Introduction

Orchids in the wild usually take up their food dissolved in rain water containing upto 15 ppm of dissolved nutrients. In the natural habitat, an orchid plant receives the necessary nutrients by way of the air and rainfall. The plants often grow in accumulated humus and the natural breakdown of organic matter. Bird droppings washed down from higher up also provide additional material. Nine elements i.e. Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus, Potash, Sulphur, Calcium and Magnesium comprise the group of nine major nutrients. Together they make up to 3.5% of the dry matter. The atmosphere and water supply carbon, hydrogen and oxygen and normally are readily available in the quantities required by the plant. The other elements are contained in the soil or in solution in the water. Generally orchids appreciate a slightly acid medium of pH between 5.2-6.5.

As the plant needs vary during the year, depending on the stage of its growth, fertilizer needs also vary. During period of rapid growth, the plant can accept and use larger amounts of fertilizers, but less frequent and more dilute applications are appropriate when growth is slower such as during the winter months. If a plant goes through period of natural dormancy, there is no point of applying fertilizer as it can not utilize it. Plants will only absorb the elements they require, in the quantity dictated by their growth. As they can not store appreciate quantities for future use, a continuous supply of nutrients is necessary. A fertilizer refers to a material added to the growing media/soil in order to supply chemical elements needed for plant nutrition and subsequently to improve growth of plants.

1. Essential plant nutrients

There are 16 essential plant nutrients and these are Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulphur (S), Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Boron (B), Molybdenum (Mo), Chlorine (Cl). These nutrients are classified as follows:

1.1 Macronutrients or Major nutrients

The nutrients which are used by plants in relatively large quantities are called macronutrients or major nutrients. These are C, H, O, N, P, K, Ca, Mg and S. Out of these N, P and K are known as primary plant nutrient and Ca, Mg and S as secondary nutrients.

Nutrients and its available form to orchid

Element	Form available to plant	Mobility in plant	Appearance of deficiency symptom
H	H_2O		
C	CO_2		
O	O_2		
N	NO_3^-, NH_4^+	Yes	Older leaf
P	$H_2PO_4^-$, HPO_4^-	Yes	Older leaf
K	K^+	Yes	Older leaf
Ca	Ca^{++}	No	Terminal bud
Mg	Mg^{++}	Yes	Older leaf
S	SO_4^-	No	Younger leaf
B	H_3BO_3	No	Terminal bud
Fe	Fe^{+++}, Fe^{++}	No	Younger leaf
Mn	Mn^{++}, Mn^{++++}	No	Younger leaf
Zn	Zn^{++}	No	Middle leaf
Cu	Cu^+, Cu^{++}	No	Younger leaf
Mo	MoO_4^-	Yes	Older leaf

1.2 Micronutrients or Minor plant nutrients

The nutrients which are required by the plants in very small quantities are called micronutrients or minor plant nutrients. They are Fe, Mn, Zn, Cu, B, Mo and Cl.

1.3 Role of different nutrients

Nitrogen (N)

Primary function: Helps in growth of green portions of plant, component of amino acids, proteins, vitamins, co-enzymes, nucleic acids, ATP and chlorophyll.

Deficiency: Reduced growth vigor, chlorosis of older leaves first, premature leaf drop.

Signs of excess: Soft growth, spindly growth, leaf curl, reduced flowering, symptoms of K deficiency.

Phosphorus (P)

Primary function: Constituent of nucleic acids, coenzymes NAD and NADP required for photosynthesis, respiration and involves in many metabolic processes and the energy compound ATP. Essential for root growth, flowering and seed production.

Deficiency: Older leaves are affected first, an increase in anthocyanin pigment and a dark blue green colouration, sometimes with necrotic areas and stunting.

Signs of excess: Symptoms of N, Zn and Fe deficiencies.

Potassium (K)

Primary function: Root growth, sugar and starch production, cell membrane integrity. It affects the efficiency of the leaves in

making fibre and plant tissue. It counterbalances excess of nitrogen.

***Deficiency*:** Dwarfing, chlorosis of older leaves first, leaf curling, leaves are large but do not function properly, shoots dieback and marginal breakdown. Its deficiency bound up with plant diseases.

***Signs of excess*:** Deficiency symptoms of N, Mg, Ca, Fe, Zn, Cu and Mn.

Calcium (Ca)

***Primary function*:** Helps in cell wall formation, cell division, neutralization of toxic metabolites.

***Deficiency*:** Poor growth, deformed newer leaves, blackened areas at leaf ends and new growths with a leading yellow edge, stunted, shortened roots, dead root tips.

***Signs of excess*:** Symptoms of Mg deficiency.

Magnesium (Mg)

***Primary function*:** Required for chlorophyll and protein production, carbohydrate metabolism, enzyme activation.

***Deficiency*:** Interveinal and marginal chlorosis starting in the older leaves, increase in appearance of anthocyanin in leaves, necrotic spotting. Premature falling of flower buds and back bulbs.

***Signs of excess*:** Symptoms of Ca deficiency.

Sulphur (S)

***Primary function*:** Required for protein formation, photosynthesis and nitrogen metabolism.

Deficiency: Root stunting, dark green veins and lighter tissue between them, general chlorosis starting with younger leaves.

Boron (B)

Primary function: Takes part in sugar transport, DNA synthesis

Deficiency: Death of meristematic tissue, swollen discolored root tips, root stunting, no flower formation.

Signs of excess: Interveinal chlorosis.

Iron (Fe)

Primary function: Component of cytochromes and ferrodoxin, synthesis of chlorophyll, helps in colouring of the blooms and the leaves.

Deficiency: Interveinal chlorosis of newer leaves, in orchid the base of the leaf becomes blacken and later on spreads into the edge of the bulb.

Manganese (Mn)

Primary function: Takes part in enzyme activation in respiration and nitrogen metabolism.

Deficiency: Interveinal chlorosis and necrotic spotting.

Signs of excess: Stunting of leaves.

Zinc (Zn)

Primary function: Involved in biosynthesis of plant growth hormone (IAA), enzyme activation.

Deficiency: Smaller distorted leaves, stunting, interveinal chlorosis of older leaves, white necrotic spotting and rosetting.

***Signs of excess*:** Symptoms of Mg and Fe deficiency.

Copper (Cu)

***Primary function*:** Constituent of chlorophyll, enzyme, helps in synthesis of vitamin-A.

***Deficiency*:** Stunted, misshapen growth.

***Signs of excess*:** Symptoms of Mg and Fe deficiency.

Molybdenum (Mo)

***Primary function*:** Involved in nitrogen and potassium metabolism.

***Deficiency*:** Chlorotic interveinal mottling, marginal necrosis, folding of the leaf, no flower formation.

Chlorine (Cl)

***Primary function*:** Constituent of photosynthetic enzymes.

***Deficiency*:** Chlorosis, necrosis, wilted leaves, club shaped thickened roots.

2. Identification of nutrient deficiency symptoms in orchids

The following nutrient deficiency symptoms are most common in orchids.

Iron deficiency

Symptom: Iron deficiency is localized on new leaves and become chlorotic between veins, necrotic spots usually absent. In extreme cases necrosis of margins and tip of leaf, sometimes extending inward and developing large areas.

Nitrogen deficiency

Symptoms: Nitrogen deficiency is localized on older leaves, foliage light green, growth stunted, leaves small, lower ones lighter yellow than upper. Yellowing followed by a drying to a light brown colour, usually little drooping. Entire yellowing of the plants in severe cases.

Potassium deficiency

Symptoms: Potassium deficiency is localized on older leaves, lower leaves mottled, usually with dead areas near tip and margins, yellowing begins at margin and continuing toward centre, margins later become brown and older leaves droop down.

Fe-deficiency in *Cym.* "Pine Clash Moon Venus"

N-deficiency in *Dendrobium gibsonii*

K-deficiency in *Coelogyne elata*

3. Management of Nutrient deficiency symptoms

Element/Source	Management
Nitrogen (N) NH_4NO_3-34%N	Foliar application of 300 ppm N (0.88gNH_4NO_3/liter) at 15 days interval and media application at monthly interval can combat the N-deficiency.
Potassium (K) KNO_3-36.5% K	Foliar application at 200 ppm K (0.55g KNO_3/liter) at 15 days interval and media application at monthly interval can combat the K-deficiency.
Iron (Fe) $FeSO_4.7H_2O$-20% Fe	Foliar application of 100 ppm Fe (0.05% $FeSO_4.7H_2O$) for adult plants and 50 ppm Fe (0.025% $FeSO_4.7H_2O$) for small plant at 15 days interval can combat the Fe-deficiency.
Boron (B) H_3BO_3-17.47% B	Foliar application of 50 ppm B (0.28g H_3BO_3 /liter) for small plant and 100 ppm for adult plant at 15 days interval combat the B-deficiency.
Molybdenum (Mo) $[(NH_4)_6Mo_7O_{24}.4H_2O]$-54.35% Mo	Foliar application of 50 ppm Mo (0.092g Ammonium molybdate $[(NH_4)_6Mo_7O_{24}.4H_2O]$ /liter) for small plant and 100 ppm Mo (0.184g Ammonium molybdate/liter) for adult plant at 15 days interval combat the Mo-deficiency.
Zinc (Zn) $ZnSO_4.7H_2O$-22.75% Zn	Foliar application of 50 ppm Zn (0.22g $ZnSO_4.7H_2O$ /liter) at 15 days interval combat the Zn-deficiency.

4. Fertilizer management

Plants produce their own food from sunlight, carbon dioxide, and water. That's the miracle called *photosynthesis.* By fertilizing, we're providing minerals that orchids can use to make photosynthesis more efficient.

4.1 What to look for in orchid fertilizer

1. Look at the label and choose a fertilizer that has the words nitrate nitrogen or ammoniacal nitrogen, not urea.
2. Look for a fertilizer with 30 percent or less nitrogen for vegetative stage. At the young stage (1 year old) 30 % nitrogen is required by *Cymbidiums*. Too much of any nutrient cannot be used by the orchid plant and as a result, merely ends up as a pollutant. As the plant grows nitrogen requirement decreases. At intermediate stage growth (second year) 20 % nitrogen is required. At the time of flowering, nitrogen should be reduced to 10-15%.
3. Look for a fertilizer with 10 percent phosphorus and potassium for vegetative stage. At the young stage 10 % phosphorus and potassium is required by *Cymbidiums*. As the plant grows P and K requirement also increases. At intermediate growth stage 20 % P and K is required. At the time of flowering stage, P and K should be increased to 25 %.
4. In most cases, a fertilizer with supplementary calcium (up to 15 percent) and magnesium (up to 8 percent) is a real plus.
5. Addition of *trace elements* (chemicals in very small amounts @ 50 ppm), including manganese, copper, zinc, boron, iron, and molybdenum, has been found to be beneficial for orchid growth and flowering.

4.2 Scheduling of fertilizer application for commercial orchids

Phase	Year/Month	Fertilizer Dose	Stage
		Cymbidium	
Growth	1st year	30: 10: 10 NPK@ 0.05 % (0.5g/ltr.) - media application at 15 days interval.	For growth of young plant
	2nd year	i) 20: 20: 20 NPK@ 0.05 % (0.5g/ltr.)-media application at 15 days interval. ii) Calcium nitrate @ 0.05%; Magnesium sulphate @ 0.1 %; Micronutrient [Iron sulphate-50ppm, Boric acid-50 ppm, Zinc sulphate-50 ppm] foliar application at bimonthly interval.	For growth of intermediate plant
Flowering -3rd year onwards	February-May	i) 30: 10: 10 NPK@ 0.1 % (1g/ltr.) - media application at 15 days interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) - media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.)-media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval	For vegetative growth

	June-August	i) 20: 20: 20 NPK @ 0.1 % (1g/ltr.) - media application at 15 days interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.)-media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For vegetative growth and flower initiation
	August-January	15: 25: 25 NPK @ 0.1 % (1g/ltr.) - media application at monthly interval.	For flowering
	March-April	Slow release fertilizer @ 5g/ltr. of water - media application (eg. Osmocote/ Nutricote/ Dynamite @ half teaspoon/plant)	At potting and repotting
		Dendrobium	
Growth	1st year	i) 20: 10: 10 NPK @ 0.1% (1g/ltr.) - foliar application at 15 days interval. ii) Calcium nitrate @ 0.05%; Magnesium sulphate @ 0.1 %; Micronutrient [Iron sulphate-50ppm,	For growth of young plant

		Boric acid-50 ppm, Zinc sulphate-50 ppm] foliar application at bimonthly interval.	
Flowering -2nd year onwards	February-May	i) 10: 20:20 NPK @ 0.2 % (2g/ltr.) - foliar application at monthly interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) -foliar application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - foliar application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For flowering
	June - September	i) 20: 10: 10 NPK @ 0.2% (2g/ltr.) - foliar application at 15 days interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) - foliar application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.)-foliar application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For vegetative growth

	October-January	20: 20: 20 NPK @ 0.2 % (2g/ltr.) - foliar application at monthly interval.	For vegetative growth and flower initiation
		Phalaenopsis	
Growth	1st year	i) 30: 10: 10 NPK@ 0.05 % (0.5g/ltr.)-media application at 15 days interval. ii) Calcium nitrate @ 0.05%; Magnesium sulphate @ 0.1 %; Micronutrient [Iron sulphate-50ppm, Boric acid-50 ppm, Zinc sulphate-50 ppm] foliar application at bimonthly interval.	For growth of young plant
Flowering - 2nd year onwards	February-May	i) 10: 20:20 NPK @ 0.1 % (1g/ltr.) - media application at monthly interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.)-media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.)-media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For flowering

	June - September	i) 30: 10: 10 NPK@ 0.1 % (1g/ltr.)- media application at 15 days interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) - media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For vegetative growth
	October-January	20: 20: 20 NPK @ 0.1 % (1g/ltr.) - media application at monthly interval.	For vegetative growth and flower initiation
		Paphiopedilum	
Growth	1st year	i) 20: 10: 10 NPK @ 0.05 % (0.5g/ltr.) - media application at monthly interval. ii) Calcium nitrate @ 0.05%; Magnesium sulphate @ 0.1 %; Micronutrient [Iron sulphate-50ppm, Boric acid-50 ppm, Zinc sulphate-50 ppm] foliar application at bimonthly interval.	For growth of young plant

Flowering -2nd year onwards	May-October	i) 20: 10:10 NPK @ 0.1 % (1g/ltr.) - media application at monthly interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.)-media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For vegetative growth
	November -April	10: 20: 20 NPK @ 0.1 % (1g/ltr.) - media application at monthly interval.	For flowering
		Cattleya	
Growth	1st and 2nd year	i) 30: 10: 10 NPK @ 0.05 % (0.5g/ltr.) - media application at 15 days interval. ii) Calcium nitrate @ 0.05%; Magnesium sulphate @ 0.1 %; Micronutrient [Iron sulphate-50ppm, Boric acid-50 ppm, Zinc sulphate-50 ppm] foliar application at bimonthly interval.	For growth of young plant

Flowering -3rd year onwards	February-May	i) 10:20:20 NPK @ 0.1 % (1g/ltr.) - media application at monthly interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) - media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For flowering
	June - September	i) 30: 10: 10 NPK@ 0.1 % (1g/ltr.) - media application at 15 days interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) - media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For vegetative growth

	October-January	20: 20: 20 NPK @ 0.1 % (1g/ltr.) -media application at monthly interval.	For vegetative growth and flower initiation
		Oncidium	
Growth	1st year	i) 20: 10: 10 NPK @ 0.05 % (0.5g/ltr.) -media application at monthly interval. ii) Calcium nitrate @ 0.05%; Magnesium sulphate @ 0.1 %; Micronutrient [Iron sulphate-50ppm, Boric acid-50 ppm, Zinc sulphate-50 ppm] foliar application at bimonthly interval.	For growth of young plant
Flowering -2nd year onwards	February-May	i) 10:20:20 NPK @ 0.1 % (1g/ltr.) - media application at monthly interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.)-media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For flowering

	June - September	i) 20: 10: 10 NPK@ 0.1 % (1g/ltr.) - media application at 15 days interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) - media application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - media application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For vegetative growth
	October-January	20: 20: 20 NPK @ 0.1 % (1g/ltr.) - media application at monthly interval.	For vegetative growth and flower initiation
		Vanda	
Growth	1st and 2nd year	i) 30: 10: 10 NPK @ 0.1% (1g/ltr.) - foliar application at 15 days interval. ii) Calcium nitrate @ 0.05%; Magnesium sulphate @ 0.1 %; Micronutrient [Iron sulphate-50ppm, Boric acid-50 ppm, Zinc sulphate-50 ppm] foliar application at bimonthly interval.	For growth of young plant

Flowering -3rd year onwards	February-May	i) 10: 20:20 NPK @ 0.2 % (2g/ltr.) - foliar application at monthly interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) - foliar application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - foliar application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For flowering
	June - September	i) 30: 10: 10 NPK @ 0.2% (2g/ltr.) - foliar application at 15 days interval. ii) Calcium nitrate @ 0.05% (0.5g/ltr.) - foliar application at monthly interval. iii) Magnesium sulphate @ 0.1 % (1g/ltr.) - foliar application at monthly interval. iv) Micronutrient [Iron sulphate-50ppm (0.25g/L), Boric acid-50 ppm (0.28g/L), Zinc sulphate-50 ppm (0.22g/L)] foliar application at monthly interval.	For vegetative growth
	October-January	20: 20: 20 NPK @ 0.2 % (2g/ltr.) - foliar application at monthly interval.	For vegetative growth and flower initiation

4.3 Types of fertilizer

Type of fertilizer	Advantages	Disadvantages	Mode of application
Water soluble	Readily available in wide range of formulations. Easy to apply. Nutrients are instantly available for plants.	Must be applied frequently every few weeks when plants are actively growing.	Diluted in water and applied by watering can.
Slow release	Easy to use, lasts a long time (3-9 months depending on formulations).	Sometimes burn sensitive orchid roots, washed out in coarse potting material, relatively expensive.	In dry form on top or incorporated into the medium.

Nitrogenous fertilizers used in orchid cultivation

Fertilizers	Chemical formulae	% N	% others
Ammonium nitrate	NH_4NO_3	35	
Ammonium sulphate	$(NH_4)_2SO_4$	21	24 S
Calcium nitrate	$Ca(NO_3)_2$	15	21 Ca

Phosphorus fertilizers used in orchid cultivation

Fertilizers	Chemical formulae	% P_2O_5	% P (% P_2O_5 x 0.43)	% others
Mono potassium phosphate	KH_2PO_4	51	22	28 K
Mono ammonium phosphate	$NH_4H_2PO_4$	48	21	12 N
Phosphoric acid	H_3PO_4	72	31	

Potassic fertilizers used in orchid cultivation

Fertilizers	Chemical formulae	% K_2O	%K (% K_2O x 0.83)	% others
Potassium sulphate	K_2SO_4	52	43	16 S
Potassium nitrate	KNO_3	44	37	13 N

Calcium fertilizers used in orchid cultivation

Fertilizers	Chemical formulae	% Ca	% others
Calcium nitrate	$Ca(NO_3)_2$	21	15 N

Magnesium fertilizers used in orchid cultivation

Fertilizers	Chemical formulae	% Mg O	% Mg	% others
Epsom salt	$MgSO_4.7H2O$	16	10	13 S
Magnesium nitrate	$Mg(NO_3)_2.6H_2O$	15	9	11 N

Micronutrient fertilizers used in orchid cultivation

Fertilizers	Chemical formulae	% essential element
Manganese sulphate	$MnSO_4.H_2O$	32 Mn
Zinc sulphate	$ZnSO_4.7H_2O$	23 Zn
Boric acid	H_3BO_3	17 B
Copper sulphate	$CuSO_4.5H_2O$	25 Cu
Iron chelate	Fe-EDTA	13 Fe

4.4 Fertilizing tips

- For young plants the amount of nitrogen is increased e.g. NPK at the ratio of 30:10:10. Too much nitrogen would produce soft, unhealthy plants.
- For intermediate growth stage, a balanced fertilizer mixture may be given e.g. NPK ratio of 20:20:20.
- For flowering stage, adults plant may require an increase in potassium and phosphorus e.g. NPK ratio of 13:27:27.
- Frequent application of fertilizers in low concentrations is the best method of feeding orchids.
- The best nitrogen source for orchids are nitrates as they are consumed the quickest of all nitrogen sources by orchids.
- Never use urea as it requires micro-organism to convert into nitrate ions that are absorbed, consumed and incorporated by orchids. This urea to nitrate conversion process takes a-long time (up to 3 months).
- The pH value is critical only during early stages of orchid germination and the seedlings are less sensitive to pH variations.
- Organic fertilizers such as cow manure must be decomposed by bacteria before the nutrients they contain can be absorbed by plants.
- Plants growing in bark and peat mixes, a higher nitrogen level may be beneficial to avoid the possibility of N-deficiency.

- It is essential that the pots should be thoroughly flushed with clean water every month to avoid salt injury.
- Because of the porous nature of the most potting mixes and the relatively large quantities of water used during the watering, a significant amount of fertilizer is lost in the water that drains away. Fairly frequent fertilizer applications are therefore generally necessary.
- Too much fertilizer causes burnt root tips and burnt leaf tips. Too little fertilizer causes pale-yellowish-leaves and increasingly smaller new growths.
- When the rate of fertilizer release is high and insufficient water present, then there is build up of high concentrations of ingredients in the solution. Increased concentrations burn the root tips and cause the roots to die. The plant can not absorb nutrient, it loses vigor, the bulbs shrivel and the plant can die.
- It is important to make an appropriate pH range of final irrigation mixture. Potassium hydroxide is used to raise the pH while phosphoric acid is commonly used to lower the pH.
- Do not raise the pH levels of fertilizer concentrates that contain calcium or magnesium and phosphorus that may cause precipitation. The pH adjustment of these fertilizers must be made in the diluted form.
- Only well rooted plants should be fertilized.

5. Food storage organ of orchids

The pseudobulb of orchids (e.g. *Cymbidium*) functions as

water, mineral and carbohydrate storage device. For maturity of pseudobulb decrease the N content and increase P and K content of the fertilizer. *Cymbidium* has three types of bulbs,

5.1 Old back-bulb without leaves: These bulbs are without leaves and act as reserve food supply during emergencies. It is advisable to leave one of these on each divided plant. Back-bulbs can make new plants but they may take years to flower.

Old back-bulb producing new plant

5.2 Old bulbs with leaves: These bulbs support the new growth and may produce flowers for a number of years depending on the variety. When dividing, the plant must retain at least two old bulbs or have one back-bulb attached to be able to re-flower next year.

5.3 New leads or bulbs: These are the youngest bulbs on the plant. While dividing, at least one old bulb and one back-bulb are retained with this bulb to ensure that the plant would flower the following year.

6. Preparation of different fertilizer mixtures

For preparation of different fertilizer mixture let us choose 3 different fertilizers like

1. Ammonium nitrate, NH_4NO_3 (35% N)

2. Monoammonium phosphate, $NH_4H_2PO_4$ (12% N, 26.9% P)

3. Potassium nitrate, KNO_3 (38% K, 13% N) or Potassium sulphate, K_2SO_4 (44.8% K).

The home made fertilizer mixture should not be stored more than 3 months.

(a) 30: 10: 10 NPK (It contains 30% N, 10% P and 10% K)

26.9g Phosphorus present in 100g $NH_4H_2PO_4$

10g P present in 37.17g $NH_4H_2PO_4$

100g $NH_4H_2PO_4$ = 12g N

37.17g $NH_4H_2PO_4$ =4.46g N

Balance N to be calculated=30-4.46=25.54g

38 g K = 100g KNO_3

10 g K = 26.3 g KNO_3

100 g KNO_3 = 13 g N

26.3 g KNO_3 = 3.42 g N

Balance N = 25.54-3.42=22.12 g N

35g N=100g NH_4NO_3

22.12g N = 63.20g NH_4NO_3

Conclusion: Add 63.2 g NH_4NO_3, 37.17g $NH_4H_2PO_4$ and 26.3 g KNO_3 (2.4: 1.41: 1) to get **30: 10: 10 NPK.**

Fertilizer dose : 0.1% 30:10:10 NPK or 300:100:100 ppm NPK- Dissolve 1.3 g of 30:10:10 NPK fertilizer mixture in 1 ltr. of water.

500 g of 30:10:10 fertilizer

NH_4NO_3= 2.4/4.81 x500=249.5g

$NH_4H_2PO_4$=146.56g

KNO_3=104.0g

(b) 20: 10: 10 NPK

26.9g Phosphorus present in 100g $NH_4H_2PO_4$

10g P present in 37.17g $NH_4H_2PO_4$

100g $NH_4H_2PO_4$ = 12g N

37.17g $NH_4H_2PO_4$ =4.46g N

Balance N to be calculated=20-4.46=15.56 g

38 g K = 100g KNO_3

10 g K = 26.3 g KNO_3

100 g KNO_3 = 13 g N

26.3 g KNO_3 = 3.42 g N

Balance N = 15.56-3.42=12.14 g N

35g N=100g NH_4NO_3

12.14g N = 34.68 g NH_4NO_3

Conclusion: Add 37g $NH_4H_2PO_4$, 34.68 g NH_4NO_3 and 26.3 g KNO_3 (1.4: 1.32: 1) to get **20: 10: 10 NPK.**

Fertilizer dose : 0.1% 20:10:10 NPK or 200:100:100 ppm NPK- Dissolve 1 g of 20:10:10 NPK fertilizer mixture in 1 ltr. of water.

500 g of 20:10:10 fertilizer
$NH_4H_2PO_4$= 1.4/3.72 x500=188.2g
NH_4NO_3=147.4g
KNO_3=134.4g

(c) 20: 20: 20 NPK

26.9g Phosphorus present in 100g $NH_4H_2PO_4$

20g P present in 74.34g $NH_4H_2PO_4$

100g $NH_4H_2PO_4$ = 12g N

74.34g $NH_4H_2PO_4$ =8.92g N

Balance N to be calculated=20-8.92=11.08 g

38 g K = 100g KNO_3

20 g K = 52.6 g KNO_3

100 g KNO_3= 13 g N

52.6 g KNO_3= 6.84 g N

Balance N = 11.08- 6.84=4.24 g N

35g N=100g NH_4NO_3

4.24g N = 12.11 g NH_4NO_3

Conclusion: Add, 74.34g $NH_4H_2PO_4$, 52.6 g KNO_3 and 12.11 g NH_4NO_3 (6.13:4.34:1) to get **20: 20: 20 NPK.**

Fertilizer dose : 0.1% 20:20:20 NPK or 200:200:200 ppm NPK- Dissolve 1.4 g of 20:20:20 NPK fertilizer mixture in 1 ltr. of water.

500 g of 20:20:20 fertilizer
$NH_4H_2PO_4$= 6.13/11.47 x500=267.2g
KNO_3=189.2g
NH_4NO_3=43.6g

(d) 10: 20: 20 NPK

26.9g Phosphorus present in 100g $NH_4H_2PO_4$

20g P present in 74.34g $NH_4H_2PO_4$

100g $NH_4H_2PO_4$ = 12g N

74.34g $NH_4H_2PO_4$ =8.92g N

Balance N to be calculated=10-8.92=1.08 g

35g N=100g NH_4NO_3

1.08g N = 3.08 g NH_4NO_3

44.8 g K = 100 g K2SO4

20 g K =44.64 g

Conclusion: Add, 74.34g $NH_4H_2PO_4$, 44.64 g K_2SO_4 and 3.08 g NH_4NO_3 (24.14: 14.5 :1) to get **10: 20: 20 NPK.**

Fertilizer dose : 0.1% 10:20:20 NPK or 100:200:200 ppm NPK- Dissolve 1.22 g of 10:20:20 NPK fertilizer mixture in 1ltr. of water.

500 g of 10:20:20 fertilizer
$NH_4H_2PO_4$= 24.14/39.64 x500=304.5g
K_2SO_4=182.9 g
NH_4NO_3=12.6 g

(e) 15: 25: 25 NPK

26.9g Phosphorus present in 100g $NH_4H_2PO_4$

25 g P present in 92.9 g $NH_4H_2PO_4$

100g $NH_4H_2PO_4$ = 12g N

92.9 g $NH_4H_2PO_4$ =11.15 g N

Balance N to be calculated=15-11.15=3.85 g

35g N=100g NH_4NO_3

3.85 g N = 11 g NH_4NO_3

44.8 g K = 100 g K_2SO_4

25 g K =55.8 g

Conclusion: Add 92.9 g $NH_4H_2PO_4$, 55.8 g K_2SO_4 and 11 g NH_4NO_3 and (8.4: 5.0: 1) to get **15: 25: 25 NPK.**

Fertilizer dose : 0.1% 15:25:25 NPK or 150:250:250 ppm NPK- Dissolve 1.6 g of 15:25:25 NPK fertilizer mixture in 1 ltr. of water.

500 g of 15:25:25 fertilizer

$NH_4H_2PO_4$= 8.4/14.4 x500=292 g

K_2SO_4=173.6 g

NH_4NO_3=34.7 g

7. Relation between strength of fertilizer solution

The strength of fertilizer solution is expressed in terms of % or in ppm.

ppm: parts per million, 1 ppm means 1 miligram of the substance dissolved in 1 liter (1000ml) of water. Similarly 1 gram (1000mg) of the substance dissolved in 1 liter of water equals to 1000ppm.

Percent: 1 gram of the substance dissolved in 100ml of water is called 1% solution. Similarly 1 gram of the substance dissolved in 1 liter (1000 ml) of water equals to 0.1% solution.

Hence 1000ppm=0.1%

1%=10,000ppm.

8. Media for growing orchids

The roots of orchids need more air space. Orchids also need growing media that drains rapidly and at the same time retains moisture. Orchids usually grow at least a year, and many times longer, between repotting, they also need materials that are slow to decompose. The combination of growing media that will work best for orchids depend on various factors, such as :

i) Frequency of irrigation: If irrigation is done frequently by the sprinkling can or hose, use materials that drain well and decompose slowly.

ii) Type of orchid: Some orchids that naturally grow on the ground, called *terrestrials,* usually prefer to be kept slightly damp all the time, while those that live on trees, called *epiphytes,* or grow on rocks, called *lithophytes,* want to dry off thoroughly between waterings.

iii) Age of the plant: Large plants usually do best in coarser growing media while the smaller plants do better in finer growing media.

iv) Size of the roots: In general, smaller roots grow better in finer, more water-retentive materials, while larger roots perform best in coarser materials.

v) Structure of the root: Root structure is another important aspect in deciding the medium. The factors to consider are the

extent of root growth (long versus short, branched versus single), the thickness of the roots, particularly that of the velamen layer. A very extensive root system of the plant has to work hard for its water and nutrition. On the contrary, a short root system requires easy and/or frequent availability of them. Velamen - A layer of white mass covers healthy roots - is actually dead tissue that acts as a sponge to rapidly absorb water and nutrients. Thick velamen is generally found on plants that like to grab a lot of water, but prefer to have their roots dry rapidly. Vandaceous plants are good examples.

vi) Water storage capabilities: Orchids with pseudobulbs can generally store water for longer periods of time than those without. Those plants having thin, strap-like leaves, such as *Oncidium* and *Cymbidium*, will lose their stored water faster than those with shorter, thick leaves, such as *Cattleyas*. Plants that don't have pseudobulbs developed thick, fleshy leaves (*Phalaenopsis*, for example) as their water storage scheme, but that is obviously not as effective as pseudobulbs.

9. Components of growing media

Tree bark: Shredded Katus bark (*Castanopsis hysterix* L.) is widely used.

Coconut husk chips (CHC), made from the pithy covering outside of the spherical, hard coconut shell and is gaining popularity as a replacement for fir bark. It is readily available, relatively cheap and wets and rewets better than bark. It also tends to be more regular in shape - chunks or cubes and facilitates better air flow throughout the root mass. CHC holds more water than bark. It lasts considerably longer than bark as well, often going three years before decomposition while bark

lasts for a year. Most CHC has a fairly high salt content, so it pays to soak and rinse it several times prior to use.

Cocopeat: It is the result of grinding the husk into coarse powder. It is often used as a substitute for peat moss in blends, but can be used alone for seedlings that like to stay damp.

Perlite: It is often referred to as "sponge rock" for the coarser grades, is expanded volcanic glass and is a great aerator of blends. It holds enough moisture to be a fairly good substrate for Semi-Hydroponic culture.

Pumice: It is similar in nature to perlite, but with a higher density and lower moisture-holding capacity

Leaf mould: Generally dried and partially decomposed leaves are used as medium. It releases lot of nutrients as decompose and retain high amount of water in it. It is good choice for terrestrial orchids.

Brick pieces: Small pieces of brick added to the media for increasing porosity of the medium. They are high in thermal mass, it is good to have them in a combination in hotter and drier climates.

Vermiculite: It is having high water holding capacity. It gradually releases nutrients for plant absorption. On an average it contains 5-8 % available potassium and 9-12 % magnesium. It can fix ammonium into a form that is not readily available to the plant. This fixed nitrogen is gradually transformed to nitrate by microorganisms making it available for plant uptake.

Sphagnum moss: It is very good for encouraging new growth, therefore a good choice for seedling orchids.

Properties of some most commonly used growing media

Media	Moisture Retention	Thermal Mass	Watering Frequency	Stability
Stone/bricks	Low	High	Frequent	High
Perlite	High	Low	Low	High
Leaf mould	Medium	Low	Medium	Low
Cocopeat	High	Low	Low	Medium
Coconut husk	Medium	Low	Medium	Medium
Sponge Rock	Low	Low	Frequent	High
Tree Fern	Medium	Low	Medium	Medium
Katus Bark	Medium	Low	Medium	Low
Charcoal	Medium	Low	Medium	Medium
Moss	High	Low	Medium	Low

Based on structure of roots of orchids, the media may be prepared. For fine rooted orchids a fine grade media is desirable, whereas orchids with thick and chunky roots will do well in coarse grade media.

Important factors determining the growing media :

1. Keeping the roots moist but not wet
2. Even drying of the mix in climate conditions
3. Keeping the roots cool
4. Avoiding large air pockets in the mix

Best grown media for *Cymbidium*: Leaf mould + Coconut husk + Bricks pieces (4:2:1)

10. Water management in orchids

Orchids prefer weakly acid water with a pH value of around 5 or 6. Proper watering is one of the most essential elements for healthy orchids. Damage to orchids is usually a result of over watering. Over watering refers to the frequency of

watering and not to the volume of water applied at any one time. Orchids require proper amounts of water, good drainage and ventilation. One of the best methods of preserving the medium in good condition is to have frequent air exchange throughout the pot. Regardless of the structure of the growing media, this can be achieved by a thorough watering which drives fresh water through to take oxygen into the pot and prevent souring. Light waterings can hasten the deterioration of the medium. When applying water, give your orchids a heavy dose, allowing them to dry out considerably.

10.1 Understanding the art of watering orchids

10.1.1 The type of pot

Orchids can be grown in clay or plastic pots. The growing media dries off much more slowly in plastic pots than it does in clay pots. With plastic, the growing media dries out from the top down, so even though the growing media may be dry on top, it may be damp 1 inch below the surface. With clay pots, the growing media dries out more uniformly (clay pots are porous, so they "breathe" and allow water to evaporate through the walls of the pot).

10.1.2 Type of growing media

Growing media vary in terms of the amount of water they retain. If a growing media absorbs a lot of water, less water is required compared to a growing media that doesn't absorb the water. To determine whether the growing media is absorbent, soak some of it in water for a few hours. Then remove the material and squeeze it. If it's absorbent, it will release this water like a sponge.

10.1.3 The age of the growing media

Fresh growing media requires much more frequent watering for the first few weeks, until it gets properly wetted. As it gets older, it retains water longer.

10.1.4 Whether the *Cymbidium* is pot-bound

An overgrown orchid (sometimes referred to as an orchid that is *pot-bound*) will dry off much more quickly than one that has plenty of space in the pot. When pot space is limited, there is less growing media to hold onto the water, so the overgrown plant quickly uses it up.

Over grown *Cymbidium* or pot-bound

10.1.5 Growing environment

Orchids and growing media in low humidity dry off more quickly, because the drier air quickly absorbs the moisture from both the plant and the growing media.

10.1.6 Temperature

Warmer temperatures increase water evaporation, because warmer air absorbs more moisture. As the plants are growing more quickly in warmer temperatures, it requires more water. If orchid is growing in a cooler temperature, less water is required.

10.1.7 Ventilation

Gentle air movement is ideal. It will keep the air fresh without excessively drying out the plants or growing media.

10.1.8 Whether the orchids are growing or dormant

When orchids are going through their winter rest period, they should be given very little water. But when they start active growth in the spring and summer, they require copious amounts of water.

10.2 Watering techniques

10.2.1 Thoroughly water the orchid in its pot

Add water slowly so that the growing media fully wet.

10.2.2 "Weigh" the pot by picking it up

Pots are heavy when it's saturated with water.

10.2.3 Wait a day or so and "weigh" it again by picking it up

Pot becomes lighter in weight as the growing media becomes drier.

10.2.4 Repeat step 11.2.3 each day until you judge, by looking at the surface and sticking finger into the top 1

inch (2.5 cm) of the growing media.

Put a chalk on the media, if moist no need to water. Keep in mind whether orchid prefers to be on the damp or dry side.

10.2.5 Note what this dry "weight" is

Now the orchid is ready to be watered thoroughly.

10.3 Watering tips

10.3.1 Grow orchids of the same type, media, pot type and size in the same area

This strategy will make watering them easier, because they'll have very similar moisture requirements.

10.3.2 Water with warm water

Very cold water can cause root and bud shock, which sets back the plant and slows down its growth. It is better to use somewhat warm water during winter months.

10.3.3 Always use a *water breaker* (a water diffuser attached to the front of hose to soften the flow of water)

A sprinkling can with a long spout with a *rose* (a water diffuser placed on the end of the water-can spout) that has many small holes works well. These devices allow thorough watering without washing out the growing media.

10.3.4 Never let the water breaker or end of the hose touch the ground or floor

As the floors and soil harbors diseases and insects, and a hose can be an effective way of spreading them.

10.3.5 When you water, water thoroughly

The water should pour out from the bottom of the pot. This method of watering ensures that the growing media is saturated and flushed out any excessive fertilizer salts.

10.3.6 Never let the pots of orchids sit in water

Excess standing water will prematurely rot the media and roots and will be a source of accumulating fertilizer salts and *pathogens* (disease-causing organisms, like bacteria, fungi, or viruses).

10.3.7 Water the orchids early in the day

That way, the foliage will have plenty of time to dry off before nightfall. Wet foliage in the evening is an invitation for disease.

10.3.8 Irrigate the orchids with slightly acidic water

Orchids prefer slightly acidic water of about pH 5.0.

10.3.9 Watering with rain water

Undoubtedly rain water is best for orchids except the atmospheric polluted area.

11. Pour-thru extraction method

Providing a proper nutritional program is essential for growing top quality plants. Sampling the root substrate for pH and electrical conductivity (EC) with the pour-thru extraction method is a quick and simple. The pour-through method has been shown to be as satisfactory as other more expensive and time consuming methods of measuring EC. Unlike sampling methods that require removal of medium from containers, the pour-through method does not disturb plant roots. The values

provide clues about a crop's performance before deficiency or toxicity symptoms appear. As nurseries implement more environmentally and economically sound growing regimes, the pour-through method should become more widely used by foliage growers for self-determination of EC levels periodically during the crop production cycle.

Sampling procedure

Collection of leachate

1. ***Irrigate the crop one hour before testing.*** The substrate must be saturated. If the water supplied by automatic irrigation system varies, then the pots/flats are watered by hand. If using constant liquid feed, usual fertilizer solution should be applied. If using periodic feeding: (a) irrigate with clear water, (b) test a day or two before fertilizing, and/or (c) test on the same day in the fertilizing cycle each time.

2. ***Place saucer under container.*** After the container has drained for 30 to 60 minutes, a plastic saucer is placed under the containers to be sampled.

3. ***Pour enough distilled water on the surface of the substrate to get 70 ml of leachate in the saucer.*** The amount of water needed will vary with container size, crop and environmental conditions.

4. ***Collect leachate for pH and EC.*** At least 70 ml of leachate should be collected for test.

5. ***Calibrate pH and EC meters prior to testing.*** The test results are only as good as the last calibrations. The instrument is

calibrated every day. Always fresh standard solutions are used.

6. ***Test your samples for pH and EC***. Test the leachate as soon as possible. Electrical conductivity will not vary much over time if there is no evaporation of the sample. However, the pH can change within two hours.

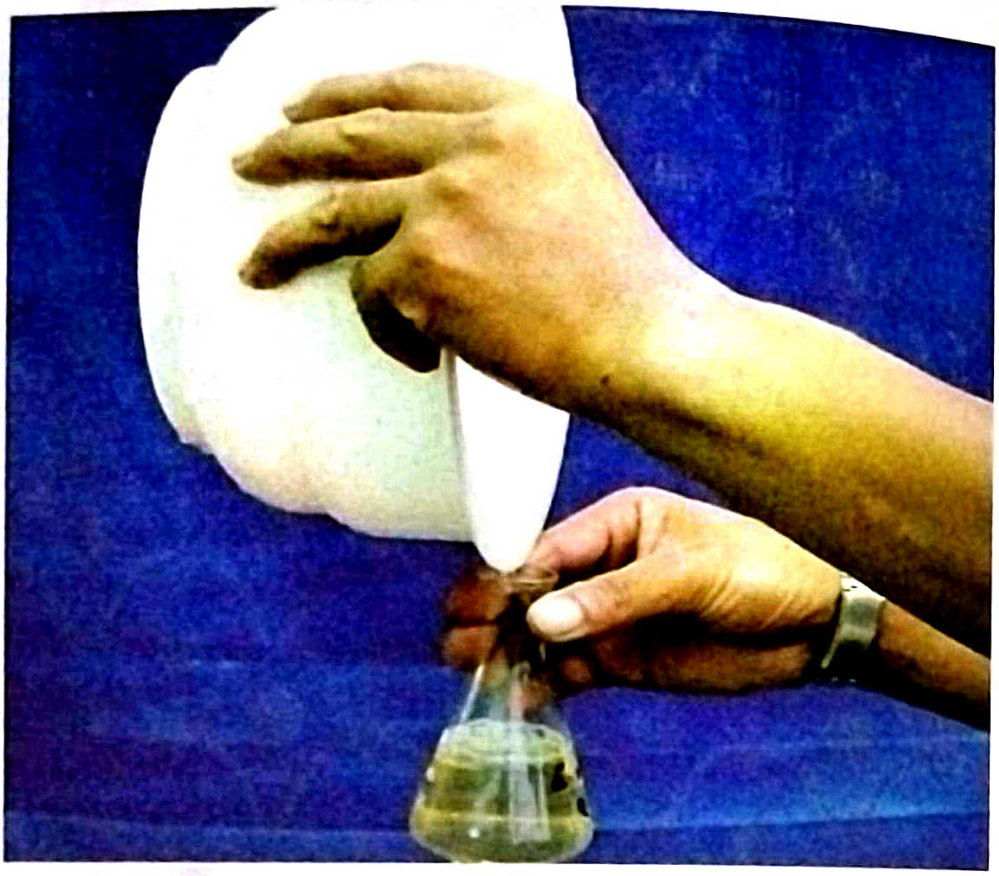
Steps in the collection of pour-thru leachate of growing media of orchid

1. Irrigate the crop thoroughly one hour before testing

2. Container for leachate collection

3. After one hour pour enough distilled water on the surface of the substrate to get 70 ml of leachate in the container

4. Collection of pour-thru leachate



5. Samples ready for measurement of pH, EC and nutritional status

Suggested substrate pour-thru pH ranges for orchids grown in soilless substrate

pH ranges	Particulars
< 4.9	Not suitable
4.9-5.2	Take corrective steps so the pH moves into the acceptable range
5.2-5.8	Acceptable range
5.8-6.0	Take corrective steps so the pH moves into the acceptable range
>6.0	Not suitable

Suggested substrate pour-thru EC ranges for orchids grown in soilless substrate

Stages of orchid	EC ranges (mS/cm)	Particulars
Establishing	< 0.7	Not suitable
	0.7-0.9	Take corrective steps so the EC moves into the acceptable range
	0.9-1.1	Acceptable range
	1.1-1.3	Take corrective steps so the EC moves into the acceptable range
	>1.3	Not suitable
Growing	<1	Not suitable
	1-1.2	Take corrective steps so the EC moves into the acceptable range
	1.2-2.4	Acceptable range
	2.4-2.6	Take corrective steps so the EC moves into the acceptable range
	>2.6	Not suitable

Blooming	<0.7	Not suitable
	0.7-0.9	Take corrective steps so the EC moves into the acceptable range
	0.9-1.3	Acceptable range
	1.3-1.5	Take corrective steps so the EC moves into the acceptable range

EC interpretation values (mS/cm) for pour-thru extraction methods

EC ranges (mS/cm)	Indication
1.0-2.6	**Low.** Suitable for seedlings of orchids
2.6-4.6	**Normal.** Standard root zone range for most established plants. Upper range for salt sensitive plants.
4.6-6.5	**High.** Reduced vigor and growth may result, particularly during hot weather.
6.6-7.8	**Very High.** May result in salt injury due to reduced water uptake. Symptoms include marginal leaf burn and wilting.
>7.8	**Extreme.** Orchids will suffer from salt injury at these levels. Immediate leaching is required.

12. Monthly culture tips for growing *Cymbidium* orchids

December and January

- It is generally recommended that spikes should be removed two to three weeks after the last flower opens.
- For a strong plant, spikes can be left longer. If they are pollinated, then the storage food on the plant will be decreased considerably.
- Provide gentle air movement, as this will eliminate many plant fungal and bacterial problems.
- Watering must be adjusted to plant activity, pot size, condition of the potting mix, etc.
- Do not allow water to fall on the flowers, as this can cause unsightly spotting.
- Application of weak nitrogenous fertilizer - once a month (10-15% N).

February

- A major reason for non flowering of *Cymbidium* orchids is keeping them too warm over the summer months.
- They should be kept under dappled light where they receive plenty of sun and cool fresh air.
- It is the time for repotting of early flowering *Cymbidium* hybrids The ideal time is just as new root activity commences in the spring after the usual winter dormancy or period of reduced activity.
- New growth is indicated by the green tips on the roots. After repotting, plants should be kept more shaded and

somewhat dryer than usual.

- Misting the foliage only for 2 to 3 weeks is required. Normal watering can be commenced once root activity is evident.
- At this time of the year when maximum vegetative growth is the aim, products high in nitrogen are desirable (20-30% N).

March

- This is the month of peak flowering of the late season hybrids in India. Spikes should be protected by stakes, wood, bamboo or strong wire.
- With the weather conditions warming up, increased attention to watering and ventilation.
- Repot the mid season hybrids if require.
- Apply plenty of water, allowing it to flow out from the holes in the pot. This ensures the mix is washed out and removed any accumulated salts.
- Smaller plants can be repotted every 6 to 12 months as they will respond to fresh compost by increasing their growth.
- Those plants which have become re-established after repotting can be fertilized. Apply high nitrogenous (30% N) fertilizer which ensures maximum vegetative growth during the period.

April

- The plants will have finished their flowering by this time, so we can plan towards next seasons flowers.
- On small plants, do not leave the spikes on for more

than 2 to 3 weeks after the last flower is open. If spikes remain longer, they can utilise the stored plant food and plant may not produce better spike in next season.

- All routine repotting should have been completed by now. If for any reason some plants still require repotting, you may wish to postpone this until February/March if they are in full growth.
- Apply liquid nitrogenous fertiliser (20-30 % N). Remember to water first to get the mix dampened and then apply.
- A shadehouse - say with 50% shade can be appropriate.
- At this time *Cymbidiums* requires low summer night temperatures, below 10-12^{0} C for next seasons flowers.
- The plants must receive plenty of water at this stage of the year, but must not be watered too frequently otherwise their roots will be killed.

May and June

- The temperature will be increasing, with the lengthening days. All plants should now be in their summer homes.
- It is generally recommended that plants should be kept in shade house, at 50% shade. Direct sun early and late in the day will be enjoyed by the plants.
- With the warmer conditions and more active growth, greater attention to watering is required.
- As the growths mature and reach their full size, a change to a lower nitrogenous fertilizer (20 % N) will

assist in the maturing of the pseudobulbs, and assist in flower bud initiation.

- High phosphorus and potash fertiliser (20-25% P and K) will be best from mid-summer on.
- Flowering may also be encouraged by applying magnesium sulphate (Epsom salts) at the rate of one teaspoonful per 5 litres of water monthly from mid summer to mid autumn (fall).

July and August

- This month can still be hot and dry, and attention to proper watering.
- By this time strong mid-day sun, 30% shade cloth will prevent burning of the foliage.
- Plenty of ventilation is provided to keep temperatures, especially night temperatures, down.
- Fertilize with low nitrogen and high phosphorus and potassium to encourage maturity and flowering (NPK 15:25:25).
- The application of epsom salts (magnesium sulphate) at the rate of 1 teaspoon per 5 litres of water should be given.
- Towards the end of the month the amount of shading provided can be gradually reduced, as the plants will appreciate stronger light at this time of the year.
- In the earlier stages, the spikes are rounded and fatter, often darker coloured, whereas leaf growths are pointed.

September

- Plenty of bright light helps in the maturity of the pseudobulbs, and development of the spikes.
- With cooler conditions, watering should be reduced in frequency.
- Water early in the mornings as the plants must be allowed to dry out before nightfall. Water lying in the axis of the growths under cold night temperatures can give rise to rots in the new growths, often leading to the loss of next year growths.
- Fertilize with low nitrogen and high phosphorus and potassium.
- If a plant is of sufficient size, but is showing no flowers, dry it out for a period. This can assist in ensuring maturity of the pseudobulb and encourage spike development.
- As the spikes develop, do not alter the orientation of the plants with respect to the light source.

October and November

- At this time of the year, vegetative growth is slow, the frequency of watering should be reduced.
- Many plants will show yellowing and loss of leaves, especially from the back pseudobulbs. This is a part of the annual growth pattern, and is nothing to become concerned about.
- Application of fertilizer can be reduced to monthly once.

13. Orchid ailments

13.1 Leaves

Yellowing leaves

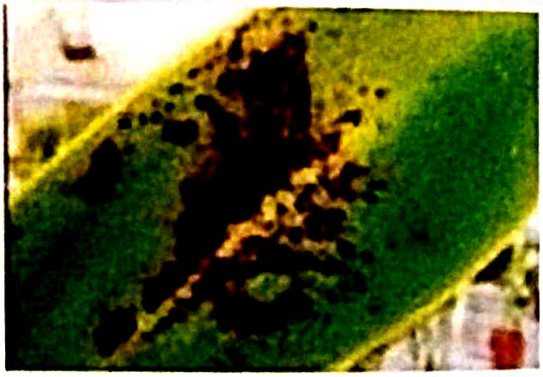
This is a normal aging process if only old leaves on backbulbs are involved. If newer leaves yellow and soften, look for

- Too much light
- Low temperature
- Lack of nitrogen (especially in tree bark)
- Loss of roots

Yellowing leaves in *Phalaenopsis*

Blackened areas on leaves

The sudden appearance of brown then black areas on exposed surface of leaves on a bright, hot day, may be sunburn. Check shading. If blackened areas increase in size, it might be bacterial or fungal disease.



Blackened areas on leaf in *Cattleya*

Shriveled pseudobulbs

A sign that the plant is losing water content, it can be caused by

- Low humidity

Shriveled pseudobulbs in *Cymbidium*

- Under watering, dry medium
- Loss of roots.

Blackened tips or ends of leaves

This could be caused by

- Overfeeding, especially in *Cymbidiums* - cease fertilizing and flush plant thoroughly with plain water
- Calcium deficiency, the turgor pressure in the cell sap is so low that the plant is not able to push nutrient to the leaf of tip. Spray with dolomitic lime at 1 g/liter of water 3-4 times a year

Blackened tips in *Cymbidium*

- Excessive soluble minerals in water - have water analyzed
- Leaf diebacks, a fungal infection - cut off blackened areas and treat with fungicide.

Brown or black streaking or mottling of leaves

This could be a virus infection.

Mottled or streaked black leaf in *Cymbidium*

Small spots on leaves, reddish brown turning black

Probably a fungus infection favoured by warmth, high humidity and poor light. Reduce humidity or dry off affected plants and treat them with fungicide.

Leaf spot in *Cattleya*

13.2 Flowers

Deformed flowers

If deformed flowers are produced each year by a plant, it is probably inherent. Destroy the plant.

An occasional deformed flower can be caused by:

1) High temperature and low humidity when buds were developing
2) Mechanical or chemical injury to bud
3) Virus infection

Deformed flowers of *Cattleya*

Rapid wilting of flower

If dorsal sepal wilts or dries early, or entire flower "goes to sleep" shortly after opening, it could be caused by:

1) Air polluted by ethylene

Flower wilting in *Cattleya*

or other gas

2) Too sudden change in climate

3) Pollination by an unknown pollinator

Spotting of flowers

Light brown or pinkish dots and spots on flower after opening usually indicate fungus, Botrytis, or sooty mold. Reduce humidity, increase ventilation or air movement, remove spotted and old flowers from greenhouse.

Spotting of flowers in *Phalaenopsis*

Punctures in flowers

Denotes presence of

1) Aphids, soft-bodied sucking insects

or

2) Thrips, small chewing insects

Punctures in flowers of *Cattleya*

Bruises on flowers

Either mechanical damage or red spider mites.

Chewed or eroded flowers, buds or roots

Shows presence of:

1) Slugs or snails

2) Cockroaches

Slugs in flowers of *Cymbidium*

Colour mottling of flowers

This could be a color-breaking virus. Isolate plant and get an experienced opinion, destroy the plant if virus infection is confirmed.

Colour break in *Vanda*

13.3 Roots

Loss of roots

Numerous causes, difficult to diagnose:

1) Overwatering
2) Black rot, an infection of *Pythium*
3) Slugs or snails
4) Excessive salt content of water
5) Potting medium old and broken down

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