Agricultural Development and Advisory Service

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Bedding Plants:

Effects of Nitrate and Conductivity on germination

for

Horticultural Development Council

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AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

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EFFECTS OF NITRATE AND CONDUCTIVITY ON GERMINATION 1988

Summary

Peat based composts were prepared with a range of nitrogen (0-400 mg/litre) and conductivity levels using a range of fertiliser materials. Seed of a number of bedding plant species (Impatiens, Petunia, Primrose, Salvia and Verbena) were sown into trays of the experimental composts. Counts were made of seedling emergence and related to the levels of nitrate and conductivity using regression analysis.

Seedling emergence was inhibited in direct proportion to increased conductivities. The effect of nitrate was generally what would be expected from its effect on conductivity, but there was some evidence of a separate toxic effect of nitrate itself on Salvia.

Introduction

Traditionally, bedding plant seed has been scatter sown into shallow boxes and pricked out into the final container 1 - 2 weeks later. Much of the seed used in the industry is expensive (up to 8p per seed in the case of Pelargonium zonale) and for this reason it has always been important to optimise the germination environment. Low germination percentages were acceptable for low priced seed, the grower simply sowing more thickly to compensate. Increasingly, seed is being sown direct into module trays or final containers. Under these circumstances where it is important that one plant develops at each station, high germination is essential.

This trial is intended to investigate the effects of nitrogen and conductivity on emergence. It is intended that the outcome of the trials is a recommendation for one compost suitable for a wide range of bedding plant species.

Materials and Method

Treatments

Five levels of nitrogen were determined as representing the range from normally acceptable (100 mg/litre N) to very high (400 mg/litre N) and very low (0 mg/litre N). A total of seven compost series were prepared, each with the same range of nitrogen levels but supplied by different base fertilisers:

i) levels of N, mg/l:

a	400
b	200
c	100
d	50
e	0

ii) base fertilisers used:

A Calcium nitrate added to achieve the levels of N above

B Calcium chloride added to give conductivities equivalent to those achieved in A. No N added

C Calcium nitrate added to achieve the levels of N above Calcium chloride added to ensure that conductivity is at a constant high level

D Calcium nitrate added to give 50 mg/litre N, calcium chloride used to give conductivities equivalent to series A

E Ammonium nitrate used to give the five levels of N

F Urea added to give the five levels of N

G Potassium nitrate used to give the five levels of N

Species: Five were chosen by growers to represent those commonly grown. The species listed in the crop diary.

Design

Each recorded plot consisted of a half seed tray containing 1 - 1.5 litres of compost into which 100 seeds were sown. On each occasion there were three replicates of each treatment.

7 series x 5 levels x 3 replicates = 105 plots

The composts were analysed for conductivity and nitrate. Emergence percentages were then related to the achieved levels using regression analysis after undergoing an angular transformation. Table 1 gives levels of significance from this formally correct analysis.

From the regression coefficients, tables of predicted results from varying levels of nitrate and conductivity have been calculated. Germination data was examined as real percentages (not-transformed) because it was considered the most appropriate, in the absence of large numbers of extreme data.

Tables showing these predicted values are in the untransformed (ie real percentages) state for the convenience of the reader and should be treated with caution.

In the final stage of the analysis a test was conducted to see if a quadratic (curve) relationship would be more appropriate than a linear (straight line) relationship. None of the tests showed strong evidence for a quadratic relationship.

Culture details

Medium Irish peat and sharp sand were mixed together in the ratio of 75:25 by volume. To this was added 3.0 kg/m^3 of chalk and 0.75 kg/m^3 of single superphosphate. This was called red base, from which all other composts were prepared, referred to by series.

'G' - a sample of red base was set aside, called G5. To a separate sample of red base, potassium nitrate was added at 3.08 kg/m^3 and mixed thoroughly. Half of this was set to one side, called G1, and half mixed with an equal quantity of red base. Half of this mixture was set aside as G2 and the process repeated to produce G3 and G4.

Blue Base - the remaining red base was taken and potassium sulphate added at 0.34 kg/m^3. This was mixed and termed blue base, used for the preparation of all composts except for G.

'E' - a sample of blue base was set aside and called E5. A further aliquot of blue base was taken and ammonium nitrate added at 1.17 kg/m^3. A sample was set aside (E1) and the remaining half mixed with an equal quantity of blue base, becoming E2. The process was repeated to produce E3 and E4.

'A', 'B', 'F' - the procedure above for E was followed with the following being substituted for ammonium nitrate; blue base was used throughout:

'F' urea 0.87 kg/m^3

'A' calcium nitrate 3.3 kg/m^3

'B' calcium chloride 1.83 kg/m^3

'D' calcium nitrate was added to blue base at 0.4 kg/m^3. A sample was set aside and called D5. The remainder was divided into four and anhydrous calcium chloride added at the following rates:

'D1'	1.60 kg/m^3
'D2'	0.89 kg/m^3
'D3'	0.23 kg/m^3
'D4'	0 kg/m^3

'C' - five separate aliquots of blue base were taken and the following added

	calcium nitrate	anhydrous calcium chloride
C5	3.34 kg/m^3	0 kg/m^3
C4	1.67 "	0.92 "
C3	0.83 "	1.37 "
C2	0.42 "	1.60 "
C1	0 "	1.83 "

The composts were prepared up to a week prior to use, except for those containing urea or ammonium nitrate which were mixed the day before use and cold stored.

One litre of each compost was analysed by ADAS soil science. Half seed trays were filled with the experimental materials and were well watered. Seed was scattered onto the surface of the composts and covered with the appropriate compost if required. Filled trays were placed into germination rooms with a continually low (domestic) level of illumination provided by fluorescent lamps. Until germination was well under way, the trays were covered with film plastic. Trays were misted as required to prevent the surface drying.

Recording

Counts of the number of seedlings with healthy, expanded cotyledons were made on two occasions:

1 germination under way
2 germination apparently complete

Culture Diary

	Impatiens Dwarf Baby (Asmer)	Petunia Super Formula (Asmer)	Primrose Easter Bouquet (Asmer)	Salvia Blaze of Fire (Asmer)	Verbena Sparkle (Asmer)
Sown	21/1	21/1	21/1	21/1	21/1
Temp, ^{o}C	20-22	20-22	18-20	20-22	20-22
Covered	light	no	no	light	yes
First count*	11	7	14	8	8
Last count*	18	14	21	15	15

* Days from sowing

Results

Summary tables of the mean observed effects appear below. Detailed tables of computer predictions appear in Appendix I. Details of compost analyses appear in Appendix II.

Table 1: Effects of nitrate and conductivity

	Impatiens		Petunia		Primrose		Salvia		Verbena	
Days from sowing	11	18	7	14	14	21	8	15	8	15
Nitrate	ns	ns	ns	ns	ns	ns	ns	**	ns	ns
Conductivity	***	***	***	***	***	***	***	***	***	***

Compost analysis showed that a wide range of nitrate and conductivities had been achieved. Nitrate levels of below 50 mg/litre were rarely found because of the natural levels occurring in peats.

Impatiens: only conductivity had any effect on emergence, the scale of effect being considerable at both the first and second counts

Petunia: conductivity was found to suppress emergence at both counts

Primrose: conductivity was found to suppress emergence at both counts

Salvia: Conductivity was found to reduce emergence at both counts, but even after this had been allowed for nitrate also depressed germination itself at the second count.

Verbena: conductivity was found to suppress emergence at both counts

Discussion

The results of the trials show clearly that of the two components tested, conductivity has a much greater effect on emergence than nitrate, although nitrate is very important because it does cause an increase in conductivity. Care must be taken in interpreting the results, however. The computer model can predict what will happen to emergence at a range of nitrate levels at a constant level of conductivity. This is not a situation to be found in real life, where the addition of a nitrate fertiliser to a compost will inevitably raise the conductivity. It is therefore more accurate to say that nitrate had no effect on germination other than that which can be explained by its contribution to increasing the conductivity with the exception of Salvia at the second count when some toxicity specifically due to nitrate is indicated.

There was no indicatation of interaction between compost series and conductivity or nitrate, suggesting that the correlation of germination with conductivity or with nitrate was similar regardless of the type of fertiliser used, eg nitrate, urea, NH_4NO_3, Ca chloride, etc.

Conclusions

The trials demonstrated that conductivity has a major influence on seedling emergence. Increasing conductivities reduced emergence of the species tested in all cases regardless of the type of fertiliser used.

The evidence for any specific effects on emergence due to nitrate was weak. A depression in emergence was observed in Salvia only. This result would suggest that further trials work may be needed. To growers, however, the question of specific toxicity arising from the use of nitrate is largely academic. The addition of nitrate fertiliser to a compost will inevitably increase conductivity and so reduce germination. Only from the use of highly contrived experimental treatments and complex statistical models was it possible to separate the two.

Recommendations

Minimal levels of conductivity must be maintained in germination composts. Optimal germination conditions may best be provided by the inclusion of lime and superphosphate only in seed composts, followed by early applications of liquid feed.

Appendix I - computer predictions of germination (%) at a range of nitrate and conductivity levels

Species - Impatiens

First count (expanded cotyledons) + 11 days from sowing

	cf microsiemens					
Nitrate	700	600	500	400	300	200
400	0	1	4	6	9	12
300	0	2	4	7	9	12
200	0	2	5	7	10	13
100	0	3	5	7	10	13
50	0	3	5	8	11	13

Last count (expanded cotyledons) + 18 days from sowing

	cf microsiemens					
Nitrate mg/l	700	600	500	400	300	200
400	7	20	34	48	62	76
300	6	20	34	48	62	75
200	6	20	34	47	61	75
100	6	19	33	47	61	75
50	6	19	33	47	61	75

Species - Petunia

First count (expanded cotyledons) + 7 days from sowing

	cf microsiemens					
Nitrate mg/l	700	600	500	400	300	200
400	8	11	14	17	20	22
300	8	11	14	16	19	22
200	8	10	13	16	19	22
100	7	10	13	16	18	21
50	7	10	13	16	18	21

Last count (expanded cotyledons) + 14 days from sowing

	cf microsiemens					
Nitrate mg/l	700	600	500	400	300	200
400	39	43	47	50	54	58
300	39	43	47	50	54	58
200	39	43	47	50	54	58
100	39	43	47	50	54	58
50	39	43	47	50	54	58

Species - Primula

Last count (expanded cotyledons) + 21 days from sowing

	cf microsiemens					
Nitrate mg/l	700	600	500	400	300	200
400	3	5	7	10	12	15
300	3	5	8	10	12	15
200	3	6	8	10	13	15
100	3	6	8	11	13	15
50	4	6	8	11	13	16

Species - Verbena

Last count (expanded cotyledons) + 15 days from sowing

	cf microsiemens					
Nitrate mg/l	700	600	500	400	300	200
400	1	3	4	6	7	8
300	1	2	4	5	7	8
200	1	2	3	5	6	8
100	0	2	3	5	6	8
50	0	2	3	4	6	7

Appendix II - achieved levels of nitrate and conductivity

Treatment	cf micro-siemens	nitrate mg/litre	Treatment	cf micro-siemens	nitrate mg/litre
A1	690	312	E1	450	165
A2	510	180	E2	345	102
A3	365	117	E3	280	63
A4	320	81	E4	315	60
A5	225	39	E5	325	22
B1	775	25	F1	310	39
B2	535	26	F2	340	41
B3	350	31	F3	270	37
B4	295	28	F4	295	51
B5	265	31	F5	225	37
C1	840	37	G1	705	342
C2	705	69	G2	450	192
C3	700	105	G3	300	108
C4	680	171	G4	135	20
C5	795	468	G5	135	20
D1	665	72			
D2	435	63			
D3	410	72			
D4	310	78			
D5	310	78			

Species - Salvia

First count (expanded cotyledons) + 8 days from sowing

	cf microsiemens					
Nitrate mg/l	700	600	500	400	300	200
400	0	2	5	9	12	16
300	0	2	6	9	13	16
200	0	3	6	10	13	17
100	0	4	7	11	14	18
50	0	4	7	11	14	18

Last count (expanded cotyledons) + 15 days from sowing

	cf microsiemens					
Nitrate mg/l	700	600	500	400	300	200
400	25	36	46	56	67	77
300	28	39	49	59	70	80
200	31	42	52	62	73	83
100	34	45	55	62	73	83
50	36	46	56	67	77	88