

BAB V

KESIMPULAN DAN SARAN

A. KESIMPULAN

Berdasarkan hasil penelitian dapat disimpulkan bahwa pemberian tembaga mulai dari konsentrasi 5 ppm sudah menghambat pertumbuhan organ tanaman (akar, batang, daun dan biji) yang menyebabkan terjadinya penurunan luas daun, berat kering, jumlah daun dan panjang akar serta batang.

Kandungan (akumulasi) tembaga (Cu) meningkat terutama pada konsentrasi 25 ppm dan kandungan (akumulasi) tembaga (Cu) tertinggi pada organ akar sebesar 41,34 $\mu\text{g}/\text{mg}$ kemudian biji 9.02 $\mu\text{g}/\text{mg}$, daun 8.83 $\mu\text{g}/\text{mg}$ dan batang 8.42 $\mu\text{g}/\text{mg}$.

Perubahan morfologis pada tanaman kedelai akibat mengakumulasi tembaga (Cu), yaitu daun berwarna kuning dan gugur, ujung akar berwarna coklat dan tebal.

B. SARAN

Berdasarkan hasil penelitian dapat diberikan saran-saran yang diharapkan dapat menjadi bahan pertimbangan berbagai pihak guna meningkatkan perkembangan ilmu pengetahuan dan memperluas wawasan mengenai toksisitas yang diakibatkan oleh logam berat. Agar didapatkan hasil yang memuaskan akan lebih baik apabila dilakukan penelitian dengan menggunakan kisaran konsentrasi tembaga yang lebih pendek (sempit) dan analisis tembaga dilakukan pada semua ulangnya serta menggunakan media tanaman yang bebas tembaga sehingga akan didapat hasil yang valid.

DAFTAR PUSTAKA

- Anonim, 1997, *Pedoman Bercocok Tanam Padi, Palawija dan Sayur-Sayuran*, Departemen Pertanian Badan Pengendalian Bimas, Jakarta.
- Arnon, I. 1971, *Mineral Nutrition Of Maize*. International Potash Institute Swit
- Bowen. H.J.M., 1996, *Trace Element In Biochemistry*, Academic Press, London, New York
- Baker. A.J.N., 1987, Metal Tolerance, *New Phytol* (Suppl), New York.
- Bercelo, J. and Posherieder, C., 1990, Water Relation as Affected by Heavy Metal Stress : a Review. *J. Plant Nutr.*
- Breckle, S.W. and Kahle, H., 1985, Growth Under Stress, Heavy Metal, dalam *Plant Roots The Hidden Half*, Marcel Dekker, New York.
- Connel, DW and D.J. Mitter. 1995, *Kimia dan Ekotoksikologi Pencemaran*, Diterjemahkan oleh Yanti Koestoer. Penerbit UI Press jakarta
- Darmono, 1981, *Logam Dalam Sistem Biologi Mahluk Hidup*, Universitas Indonesia Press, Jakarta.
- Djuangsih, N.H, Benjito dan Salim, *Aspek Toksikologi Lingkungan*, Lembaga Ekologi Universitas Padjajaran, Bandung.
- Dwidjoseputro, D, 1981, *Pengantar Fisiologi Tumbuhan*, Penerbit PT. Gramedia, Jakarta.
- Epstein, 1972, *Mineral Nutrition of Plant : Principle And Perspective Willet Eastern, Ltd Bombai*.
- Ehrlich, P.R., 1970, *Population Resources, Environment Uses In Human Ecology*, San Fransisco, WH Freemah and Comp.
- Fitter, AM. dan Goldsworthy, *Fisiologi Tanaman Budidaya Tropik*, Gadjah Mada University Press.
- Foth, H, 1994, *Dasar-Dasar Ilmu Tanah*, Gadjah Mada Universitas Press, Yogyakarta
- Golsworthy, P.R dan Fishert, N.M., 1992, *Fisiologi Tanaman Budidaya Tropik*, Edisi 2, Gadjah Mada University Press. Yogyakarta.

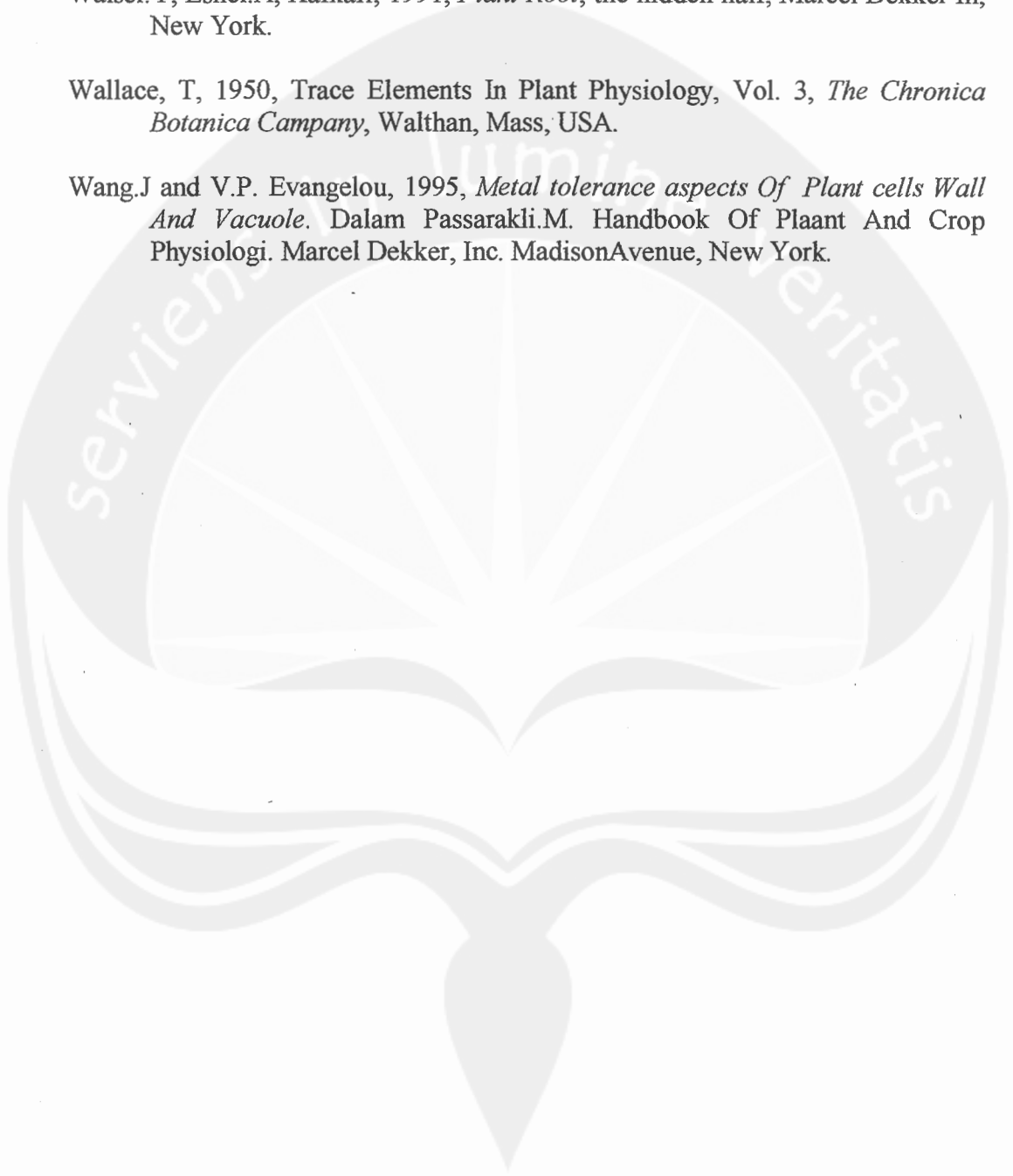
- Hart, B.T., 1988, *Australian Water Quality Criteria For Heavy Metal*, Australian Government Publishing Sevis, Canberra.
- Kennedy, C.D and Gonsalves, F.A.N., 1987, *The Action Of Divalent Zinc, cadmium, Mercury, Copper and Lead On The Trans-Root Potential And H^+ Efflux Of Excised Root*, J. exp. Bot.
- Loveless.A.R, 1987, *Prinsip-Prinsip Biologi Tumbuhan Untuk Daerah Tropik*, PT. Gramedia, Jakarta.
- Larcher,W, 1980, *Physiological Plant Ekology*, Springer Verlag Berlin Hendelberg, New York.
- Marschner, H, 1986, *Mineral Nutrition of Higher Plant*, Academic Press, London.
- Nogle and Fritz, 1979, *Introductory Plant Physiology*, Prentice hall of India, privateLimited, New Delhi.
- Odum M.E., 1981, *Dasar-Dasar Ekologi*, Edisi 3, Penerbit Gadjah Mada University Press, Yogyakarta.
- Polar, H, 1994, *Pencemaran Dan Toksikologi Logam Berat*, Reneka Cipta, Jakarta.
- Passarakli.M, 1995, *Handbook Of Plant And Crop Physiologi*, Marce Dekker, Inc. Madison Avenue. New York.
- Rauser.W.E and C.A. Ackerly, 1987, *Localization Of Cadmium In Granules Within Differentiating And Nature Cells*, Can.J. Bot. Canada.
- Robson, A.D and Reuter, 1981, *Diognosis of Copper Deficiency an Toxicity*, In *Copper Soil and Plant*, Academic press, Sidney.
- Soeseno, 1988, *Dasar – Dasar Ilmu Tanah*, Gadjah Mada University Press, Yogyakarta.
- Suprpto, 1985, *Bertanam Kedelai*, Penebar Swadaya, Jakarta.
- Tiffen, L.O., 1972, *Translocation Of Micronutrien In Plant*, In *Micronutrien, In Agriculture*, *Soil Science Society Of America*, Madison.
- Treshow, M., 1974, *Environment And Plant Response*, Mc Grow Book Company, New York.

Woolhouse, H.W, 1983, Toxicity And Tolerance in Responsive of Plant to Metal. In Langs, *Encyclopedia of Plant Physiology*, New series vol 112 C , SpringerVerlag, Berlin.

Waisel, Y, Eshel, A, Kafkafi, 1991, *Plant Root*, the hidden half, Marcel Dekker In, New York.

Wallace, T, 1950, Trace Elements In Plant Physiology, Vol. 3, *The Chronica Botanica Company*, Waltham, Mass, USA.

Wang, J and V.P. Evangelou, 1995, *Metal tolerance aspects Of Plant cells Wall And Vacuole*. Dalam Passarakli, M. Handbook Of Plant And Crop Physiologi. Marcel Dekker, Inc. Madison Avenue, New York.





Lampiran

Lampiran 1

1.a. Pengaruh Cu terhadap jumlah daun tanaman kedelai (Minggu)

Umur tanaman	Konsentrasi (ppm)						Total
(A)	0	5	10	15	20	25	
2	16	16	11	13	10	8	
	17	15	14	11	9	9	
	18	17	15	13	11	8	
	17	15	14	11	10	9	
	18	17	16	11	10	9	
Jumlah	86	80	70	59	50	43	388
Rata-rata	17.2	16	14	11.8	10	8.6	
4	40	37	36	36	34	28	
	42	40	36	32	32	29	
	42	38	35	34	30	28	
	40	38	37	32	32	29	
	40	40	36	34	30	27	
Jumlah	204	193	180	168	158	141	1044
Rata-rata	40.8	38.6	36	33.6	31.6	28.2	
6	78	77	68	65	65	64	
	74	75	70	67	63	58	
	77	76	72	64	60	56	
	76	70	66	62	62	58	
	76	72	69	64	60	56	
Jumlah	381	370	345	322	310	292	2020
Rata-rata	76.2	74	69	64.4	62	58.4	
8	106	100	97	95	89	80	
	102	98	96	94	86	82	
	104	100	95	95	87	78	
	102	97	96	94	88	80	
	100	99	97	94	90	78	
Jumlah	514	494	481	472	440	398	2799
Rata-rata	102.8	98.8	96.2	94.4	88	79.6	
10	90	82	78	74	70	62	
	87	84	77	70	68	60	
	89	82	79	70	68	64	
	88	80	78	72	69	58	
	88	79	76	74	66	60	
Jumlah	442	407	388	360	341	304	2242
Rata-rata	88.4	81.4	77.6	72	68.2	60.8	
Total	1627	1544	1464	1381	1299	1178	8493
Rerata total	65.08	61.76	58.56	55.24	51.92	47.12	

1.b. Pengaruh Cu terhadap rerata jumlah daun tanaman kedelai (Minggu)

Umur tanaman	Konsentrasi (ppm)						Rata-rata
	0	5	10	15	20	25	
2	17.2	16	14	11.8	10	8.6	12.93 ^g
4	40.8	38.6	36	33.6	31.6	28.2	34.8 ^h
6	76.2	74	69	64.4	62	58.4	67.33 ⁱ
8	102.8	98.8	96.2	94.4	88	79.6	93.3 ^j
10	88.4	81.4	77.6	72	68	60.8	74.7 ^k
Rata-rata	65.08 ^a	61.76 ^b	58.56 ^c	55.24 ^d	51.92 ^e	47.12 ^f	

Huruf yang beda menunjukkan beda nyata pada taraf $\alpha = 5\%$

$$FK = \frac{8493^2}{5 \cdot 5 \cdot 6} = 480873.66$$

$$JKT = 16^2 + 17^2 + \dots + 60^2 - FK = 612575 - 480873.66 = 131701.34$$

$$JKP = \frac{86^2 + 204^2 + \dots + 304^2}{5} - FK = 612245.8 - 480873.66 = 131372.14$$

$$JKG = JKT - JKP = 131701.34 - 131372.14 = 329.2$$

$$db \text{ perlakuan} = a \cdot b - 1 = 5 \cdot 6 - 1 = 29$$

$$db \text{ galat} = a \cdot b(r - 1) = 5 \cdot 6(5 - 1) = 120$$

$$db \text{ total} = r \cdot a \cdot b - 1 = 5 \cdot 5 \cdot 6 - 1 = 149$$

$$JK(A) = \frac{388^2 + \dots + 2242^2}{5 \cdot 6} - FK = 606061.5 - 480873.66 = 125187.84$$

$$JK(B) = \frac{1627^2 + \dots + 1178^2}{5 \cdot 5} - FK = 486264.28 - 480873.66 = 5390.62$$

$$JK(AB) = JKP - JK(A) - JK(B) = 131372.14 - 125187.84 - 5390.62 = 793.68$$

$$db \text{ faktor } (A) = a - 1 = 5 - 1 = 4$$

$$db \text{ faktor } (B) = b - 1 = 6 - 1 = 5$$

$$db \text{ interaksi } (AB) = (a - 1)(b - 1) = 20$$

$$KT(A) = \frac{JK(A)}{4} = \frac{125187.84}{4} = 31296.96$$

$$KT(B) = \frac{JK(B)}{5} = \frac{5390.62}{5} = 1078.124$$

$$KT(AB) = \frac{JK(AB)}{20} = \frac{793.68}{20} = 39.684 \approx 39.68$$

$$KTG = \frac{JKG}{120} = \frac{329.2}{120} = 2.743 \approx 2.74$$

$$F \text{ Hitung } (A) = \frac{KT(A)}{KTG} = \frac{31296.96}{2.74} = 11409.755 \approx 11409.76$$

$$F \text{ Hitung } (B) = \frac{KT(B)}{KTG} = \frac{1078.124}{2.74} = 393.05$$

$$F \text{ Hitung } (AB) = \frac{KT(AB)}{KTG} = \frac{39.684}{2.74} = 14.467 \approx 14.47$$

1.c. Tabel ANAVA rerata jumlah daun tanaman kedelai

Sumber Keragaman	DB	JK	KT	F Hitung	F Tabel (5%)
Perlakuan	29	131372.14	-		
A	4	125187.84	31296.96		
B	5	5390.62	1078.124	11409.76*	2.44
Interaksi (AB)	20	793.68	39.68	393.05*	2.29
Galat	120	329.2	2.74	14.47*	1.65
Total	149	131701.34			

* Nyata pada taraf $\alpha = 5\%$

Uji DMRT Daun Tanaman

$$S\hat{y} = \left(\frac{KTG}{30} \right)^{\frac{1}{2}} = \left(\frac{0.163}{30} \right)^{\frac{1}{2}} = 0.302 \approx 0.30$$

Wilayah nyata terpendek

- $p \quad Rp = rp \cdot S\hat{y}$
2. $(2.77) (0.30) = 0.831$
 3. $(2.92) (0.30) = 0.876$
 4. $(3.02) (0.30) = 0.906$
 5. $(3.09) (0.30) = 0.927$

	0,927	0,906	0,876	0,831	
	12.96	34.8	67.33	74.7	93.3
93.3	80.34	58.5	25.97	18.6	0
74.7	61.74	16.2	7.37	0	
67.33	54.37	32.53	0		
34.8	21.84	0			
12.96	0				

Uji DMRT Konsentrasi Cu

$$S\hat{y} = \left(\frac{KTG}{36} \right)^{\frac{1}{2}} = \left(\frac{2.743}{36} \right)^{\frac{1}{2}} = 0.276 \approx 0.28$$

Wilayah nyata terpendek

- $p \quad Rp = rp \cdot S\hat{y}$
2. $(2.77) (0.28) = 0.7756$
 3. $(2.92) (0.28) = 0.8176$
 4. $(3.02) (0.28) = 0.8456$
 5. $(3.09) (0.28) = 0.8652$
 6. $(3.15) (0.28) = 0.882$

	0.882	0.8652	0.8456	0.8176	0.7756	
	47.12	51.92	55.24	58.56	61.76	65.08
65.08	17.96	13.16	9.84	6.52	3.32	0
61.76	14.64	9.84	6.52	3.2	0	
58.56	11.44	6.64	3.32	0		
55.24	4.8	3.32	0			
51.92	8.12	0				
47.12	0					



Lampiran 2

2.a. Pengaruh Cu terhadap panjang akar tanaman kedelai pada umur 10 minggu

Ulangan	Konsentrasi (ppm)						Total
	0	5	10	15	20	25	
1	40.5	40.5	40	35	32.5	30.5	
2	42.5	39	35	33.5	29	31.5	
3	45	40	36	36	30	32	
4	39	38	35	34	30.5	28	
5	40	36	36	32	33	29	
Jumlah	207	193.5	182	170.5	155	151	1058
Rata-rata	41.4	38.7	36.4	34.1	31	30.2	

$$FK = \frac{1058^2}{30} = 37312.13$$

$$JKT = 40.5^2 + 42.5^2 + \dots + 29^2 - FK = 37890 - 37312.13 = 577.87$$

$$JKP = \frac{207^2 + 193.5^2 + \dots + 151^2}{5} - FK = 37807.7 - 37312.13 = 495.57$$

$$JKG = JKT - JKP = 577.87 - 495.57 = 82.3$$

$$KTP = \frac{JKP}{5} = \frac{495.57}{5} = 99.114 \approx 99.11$$

$$KTG = \frac{JKG}{24} = \frac{82.3}{24} = 3.429 \approx 3.43$$

$$F \text{ Hitung} = \frac{KTP}{KTG} = \frac{99.11}{3.43} = 28.903 \approx 28.90$$

2.b. Tabel ANAVA panjang akar tanaman kedelai pada umur 10 minggu

Sumber Keragaman	DB	JK	KT	F hitung	F tabel (5%)
Perlakuan	5	495.57	99.11	28.90*	2,62
Galat	24	82.3	3.43		
Total	29	577.87			

* Nyata pada taraf $\alpha = 5\%$

Uji DMRT

$$S\hat{y} = \left(\frac{KTC}{5} \right)^{\frac{1}{2}} = \left(\frac{3.43}{5} \right)^{\frac{1}{2}} = 0.828 \approx 0.83$$

Wilayah nyata terpendek

<i>p</i>	$Rp = rp \cdot S\hat{y}$
2	(2.92) (0.83) = 2.4236
3	(3.07) (0.83) = 2.5481
4	(3.15) (0.83) = 2.6145
5	(3.22) (0.83) = 2.6726
6	(3.28) (0.83) = 2.7224

	2.7224	2.6726	2.6145	2.5481	2.4236	
	30.2	31	34.1	36.4	38.7	41.4
41.4	11.2	10.4	7.3	5	27	0
38.7	8.5	7.7	4.6	2.3	0	
36.4	6.2	5.4	2.3	0		
34.1	3.9	3.1	0			
31.4	1.2	0				
29.6	0					

Lampiran 3

3.a. Pengaruh Cu terhadap panjang batang tanaman kedelai pada umur 10

minggu

Ulangan	Konsentrasi (ppm)						Total
	0	5	10	15	20	25	
1	34.5	30	26.5	26.5	24.5	22.5	
2	34	32	28.5	25.5	23	20	
3	33	34	26	26	25	23	
4	35	28	28	24	23.5	19	
5	34	30	29.5	25	23	25	
Jumlah	170.5	154	138.5	127	119	109.5	818.5
Rata-rata	34.1	30.8	27.7	25.4	23.8	21.9	

$$FK = \frac{818.5^2}{30} = 22331.408$$

$$JKT = 34.5^2 + 34^2 + \dots + 25^2 - FK = 22911.25 - 22331.408 = 579.842$$

$$JKP = \frac{170^2 + 154^2 + \dots + 109.5^2}{5} - FK = 22849.75 - 22331.408 = 518.342$$

$$JKG = JKT - JKP = 579.842 - 518.342 = 61.5$$

$$KTP = \frac{JKP}{5} = \frac{518.342}{5} = 103.668 \approx 103.67$$

$$KTG = \frac{JKG}{24} = \frac{61.5}{24} = 2.562 \approx 2.56$$

$$F \text{ Hitung} = \frac{KTP}{KTG} = \frac{103.668}{2.562} = 40.46$$

3.b. Tabel ANAVA panjang batang tanaman kedelai pada umur 10 minggu

Sumber Keragaman	DB	JK	KT	F hitung	F tabel (5%)
Perlakuan	5	518.342	103.67	40.46*	2,62
Galat	24	61.5	2.56		
Total	29	579.842			

* Nyata pada taraf $\alpha = 5\%$

Uji DMRT

$$S\hat{y} = \left(\frac{KTC}{5} \right)^{\frac{1}{2}} = \left(\frac{2.56}{5} \right)^{\frac{1}{2}} = 0.715 \approx 0.72$$

Wilayah nyata terpendek

p	$Rp = rp \cdot S\hat{y}$
2	$(2.92) (0.72) = 2.1024$
3	$(3.07) (0.72) = 2.2104$
4	$(3.15) (0.72) = 2.2268$
5	$(3.22) (0.72) = 2.3184$
6	$(3.28) (0.72) = 2.3616$

	2.3616	2.3184	2.2268	2.2104	2.1024	
	21.9	29.8	25.4	27.7	30.8	34.1
34.1	12.2	10.3	8.7	6.4	3.3	0 d
30.8	8.9	7	5.4	3.1	0 c	
27.7	5.8	3.9	2.3	0 b		
25.4	3.5	1.6	0 a			
23.8	1.9	0				
21.9	0					

Lampiran 4

4.a. Pengaruh Cu terhadap luas daun tanaman kedelai pada umur 10 minggu

Ulangan	Konsentrasi (ppm)						Total
	0	5	10	15	20	25	
1	25.26	20.32	19.02	15.02	13.32	13.49	
2	24.72	22.85	18.19	15.97	12.49	9.66	
3	24.03	19.68	16.03	16.43	11.60	11.62	
4	22.14	20.08	16.61	14.72	12.14	10.43	
5	24.74	20.19	16.66	13.89	11.32	10.16	
Jumlah	120.89	103.12	86.51	76.03	60.87	55.36	502.78
Rata-rata	24.18	20.62	17.30	15.21	12.17	11.07	

$$FK = \frac{502.78^2}{30} = 8426.257 \approx 8426.26$$

$$JKT = 25.26^2 + 24.72^2 + \dots + 10.16^2 - FK = 9091.08 - 8426.26 = 664.82$$

$$JKP = \frac{120.89^2 + 103.12^2 + \dots + 55.36^2}{5} - FK = 9056.511 - 8426.26 = 630.25$$

$$JKG = JKT - JKP = 664.82 - 630.25 = 34.57$$

$$KTP = \frac{JKP}{5} = \frac{630.25}{5} = 126.05$$

$$KTG = \frac{JKG}{24} = \frac{34.57}{24} = 1.44$$

$$F \text{ Hitung} = \frac{KTP}{KTG} = \frac{126.05}{1.44} = 87.53$$

4.b. Tabel ANAVA luas daun tanaman kedelai pada umur 10 minggu

Sumber Keragaman	DB	JK	KT	F hitung	F table (5%)
Perlakuan	5	630.25	126.05	87.53	2,62
Galat	24	34.57	1.44		
Total	29	664.82			

* Nyata pada taraf $\alpha = 5\%$

Uji DMRT

$$S\hat{y} = \left(\frac{KTC}{5} \right)^{\frac{1}{2}} = \left(\frac{1.44}{5} \right)^{\frac{1}{2}} = 0.536 \approx 0.54$$

Wilayah nyata terpendek

<i>p</i>	$Rp = rp \cdot S\hat{y}$
2	(2.92) (0.54) = 1.5768
3	(3.07) (0.54) = 1.6578
4	(3.15) (0.54) = 1.701
5	(3.22) (0.54) = 1.7388
6	(3.28) (0.54) = 1.7712

	1.7712	1.7388	1.701	1.6578	1.5768	
	11.07	12.17	15.21	17.30	20.62	24.18
24.18	13.11	12.01	8.97	6.88	3.56	0
20.62	9.55	8.45	5.41	3.32	0	
17.30	6.23	5.13	2.09	0		
15.21	4.14	3.04	0			
12.17	1.1	0				
11.07	0					

Lampiran 5

5.a. Pengaruh Cu terhadap berat kering (gr) organ tanaman (akar,batang, daun dan biji) kedelai pada umur 10 minggu

Organ Tanaman	Konsentrasi (ppm)						Total	
	(A)	0	5	10	15	20		25
Akar		3,12	3,03	2,06	0,8	0,84	0,42	
		3,59	2,94	1,74	1,15	0,76	0,17	
		2,93	2,18	1,56	1,23	0,45	0,6	
		2,8	3,12	2,42	0,92	0,14	0,35	
		3,64	2,88	1,86	0,74	1,16	0,12	
Jumlah	16,08	14,15	9,64	4,84	3,35	1,66	49,72	
Rata-rata	3,216	2,83	1,928	0,968	0,67	0,332		
Batang		4,06	3,37	1,66	1,32	0,62	0,32	
		3,47	3,16	2,32	1,72	0,59	0,16	
		3,19	2,96	2,41	1,44	0,78	0,74	
		3,57	2,77	1,77	0,53	0,98	0,4	
		2,86	2,41	1,37	0,42	0,54	0,18	
Jumlah	17,15	14,67	9,53	5,43	3,51	1,8	52,09	
Rata-rata	3,43	2,934	1,906	1,086	0,702	0,36		
Daun		2,8	1,78	1,34	0,64	0,24	0,39	
		1,92	1,96	0,95	0,58	0,28	0,56	
		1,88	1,74	0,88	0,54	0,18	0,43	
		2,96	2,04	1,08	0,49	0,32	0,28	
		1,76	1,54	0,66	0,45	0,16	0,3	
Jumlah	11,32	9,06	4,91	2,7	1,18	1,96	31,13	
Rata-rata	2,264	1,812	0,982	0,54	0,236	0,392		
Biji		6,97	6,54	5,15	5,24	4,28	3,48	
		6,84	5,76	5,37	3,37	2,66	3,28	
		6,72	6,48	4,95	4,64	3,37	2,46	
		6,68	5,63	5,04	4,1	3,18	2,03	
		6,7	6,35	4,23	3,28	3,07	2,18	
Jumlah	33,91	30,76	24,74	20,63	16,56	13,43	140,03	
Rata-rata	6,782	6,152	4,948	4,126	3,312	2,686		
Total	78,46	68,64	48,82	33,6	24,6	18,85	272,97	
Rerata total	3,923	3,432	2,441	1,68	1,23	0,9425		

5.b. Pengaruh Cu terhadap rerata berat kering (gr) organ tanaman kedelai

Organ Tanaman	Konsentrasi (ppm)						Rata-rata
	0	5	10	15	20	25	
Akar	3,22	2,83	1,93	0,97	0,67	0,33	1,66 ^a
Batang	3,43	2,93	1,91	1,09	0,7	0,36	1,74 ^a
Daun	2,26	1,81	0,98	0,54	0,24	0,39	1,04 ^b
Biji	6,78	6,15	4,95	4,13	3,31	2,69	4,67 ^c
Rata-rata	3,92 ^a	3,43 ^b	2,44 ^c	1,68 ^d	1,23 ^e	0,94 ^f	

Huruf yang berbeda menunjukkan beda nyata pada taraf $\alpha = 5\%$

$$FK = \frac{272.97^2}{5 \cdot 4 \cdot 6} = 620.938 \approx 620.94$$

$$JKT = 3.12^2 + 3.59^2 + \dots + 13.14^2 - FK = 1029.513 - 620.94 = 408.573$$

$$JKP = \frac{16.08^2 + \dots + 13.43^2}{5} - FK = 1013.895 - 620.94 = 392.954$$

$$JKG = JKT - JKP = 408.573 - 392.954 = 15.619 \approx 15.62$$

$$db \text{ perlakuan} = a \cdot b - 1 = 4 \cdot 6 - 1 = 23$$

$$db \text{ galat} = a \cdot b(r - 1) = 4 \cdot 6(5 - 1) = 96$$

$$db \text{ total} = r \cdot a \cdot b - 1 = 5 \cdot 4 \cdot 6 - 1 = 119$$

$$JK(A) = \frac{49.71^2 + \dots + 140.03}{5 \cdot 6} - FK = 858.73 - 620.94 = 237.838$$

$$JK(B) = \frac{78.46^2 + \dots + 18.84}{5 \cdot 4} - FK = 766.99 - 620.94 = 146.10$$

$$JK(AB) = JKP - JK(A) - JK(B) = 392.954 - 237.838 - 146.10 = 9.063$$

$$db \text{ faktor } (A) = a - 1 = 4 - 1 = 3$$

$$db \text{ faktor } (B) = b - 1 = 6 - 1 = 5$$

$$db \text{ interaksi } (AB) = (a - 1)(b - 1) = 15$$

$$KT(A) = \frac{JK(A)}{3} = \frac{237.838}{3} = 79.279 \approx 79.28$$

$$KT(B) = \frac{JK(B)}{5} = \frac{146.10}{5} = 29.22$$

$$KT(AB) = \frac{JK(AB)}{15} = \frac{9.063}{15} = 0.604$$

$$KTG = \frac{JKG}{96} = \frac{15.62}{96} = 0.162$$

$$F \text{ Hitung } (A) = \frac{KT(A)}{KTG} = \frac{79.28}{0.162} = 489.38$$

$$F \text{ Hitung } (B) = \frac{KT(B)}{KTG} = \frac{29.22}{0.162} = 180.37$$

$$F \text{ Hitung } (AB) = \frac{KT(AB)}{KTG} = \frac{0.604}{0.162} = 3.729 \approx 3.73$$

5.c. Tabel ANAVA rerata berat kering organ tanaman kedelai

Sumber Keragaman	DB	JK	KT	F Hitung	F Tabel (5%)
Perlakuan	23	393,001			
A	3	237,838	79,28	486,38*	2,71
B	5	146,1	29,22	179,26*	2,32
Interaksi (AB)	15	9,063	0,604	3,71*	1,77
Galat	96	15,62	0,163		
Total	119				

* Nyata pada taraf $\alpha = 5\%$

Uji DMRT Organ Tanaman

$$S\hat{y} = \left(\frac{KTG}{24} \right)^{\frac{1}{2}} = \left(\frac{0.163}{24} \right)^{\frac{1}{2}} = 0.082 \approx 0.08$$

Wilayah nyata terpendek

- p $Rp = rp \cdot S\hat{y}$
6. (2.80) (0.08) = 0.224
 7. (2.95) (0.08) = 0.236
 8. (2.05) (0.08) = 0.164

	0,236	0,224	0,164		
	1,04	1,66	1,74	4,67	
4,67	3,63	3,01	2,93	0	
1,77	0,69	0,07	0		
1,66	0,62	0			
1,04	0				

Uji DMRT Konsentrasi Cu

$$S\hat{y} = \left(\frac{KTG}{30} \right)^{\frac{1}{2}} = \left(\frac{0.163}{30} \right)^{\frac{1}{2}} = 0.073 \approx 0.07$$

Wilayah nyata terpendek

- p $Rp = rp \cdot S\hat{y}$
7. (2.80) (0.07) = 0.196
 8. (2.95) (0.07) = 0.2065
 9. (2.05) (0.07) = 0.1435
 10. (3.12) (0.07) = 0.2184
 11. (3.18) (0.07) = 0.2226

	0.2226	0.2184	0.2065	0.196	0.1435	
	0.94	1.23	1.68	2.44	3.43	3.92
3.92	2.98	2.69	2.24	1.48	0.49	0
3.43	2.49	2.2	1.75	0.99	0	
2.44	1.5	1.27	0.78	0		
1.68	0.74	0.45	0			
1.23	0.29	0				
0.94	0					



Lampiran 6

6.a. Akumulasi Cu ($\mu\text{g}/\text{mg}$) Pada Organ Tanaman

Organ Tanaman	Konsentrasi (ppm)						Rata-rata
	0	5	10	15	20	25	
Akar	6.80	11.46	49.36	45.17	57.47	77.78	41.34
Batang	6.28	5.39	6.22	12.40	10.69	9.56	8.42
Daun	6.80	7.46	4.4	6.55	6.65	21.14	8.83
Biji	6.83	9.63	8.98	9.78	8.61	10.31	9.02
Rata-rata	6.68	8.49	17.24	18.48	20.86	29.70	

Lampiran 7

7.a. Jumlah daun kuning tanaman kedelai

Ulangan	Konsentrasi (ppm)						Total
	0	5	10	15	20	25	
1	65	95	110	110	120	135	
2	67	98	108	118	126	138	
3	63	87	102	119	129	136	
4	65	85	100	120	118	134	
5	68	92	98	116	124	129	
Jumlah	328	457	518	583	617	672	3175
Rata-rata	65.6	91.4	103.6	116.6	123.4	134.4	

$$FK = \frac{3175^2}{30} = 336020.833$$

$$JKT = 65^2 + 67^2 + \dots + 129^2 - FK = 351811 - 336020.83 = 15790.167$$

$$JKP = \frac{328^2 + 457^2 + \dots + 672^2}{5} - FK = 351383.8 - 336020.83 = 15362.97$$

$$JKG = JKT - JKP = 15790.167 - 15362.967 = 427.2$$

$$KTP = \frac{JKP}{5} = \frac{15362.97}{5} = 3072.593 \approx 3072.59$$

$$KTG = \frac{JKG}{24} = \frac{427.2}{24} = 17.8$$

$$F \text{ Hitung} = \frac{KTP}{KTG} = \frac{3072.59}{17.8} = 172.617 \approx 172.62$$

7.b. Tabel ANAVA jumlah daun kuning pada tanaman kedelai

Sumber Keragaman	DB	JK	KT	F hitung	F tabel (5%)
Perlakuan	5	15362.97	3072.59	172.62*	2,62
Galat	24	427.2	17.8		
Total	29	15790.16			

* Nyata pada taraf $\alpha = 5\%$

Uji DMRT

$$S\hat{y} = \left(\frac{KTC}{5} \right)^{\frac{1}{2}} = \left(\frac{17.8}{5} \right)^{\frac{1}{2}} = 1.886 \approx 1.89$$

Wilayah nyata terpendek

p	$Rp = rp \cdot S\hat{y}$
2	$(2.92)(1.89) = 5.5188$
3	$(3.07)(1.89) = 5.8023$
4	$(3.15)(1.89) = 5.9535$
5	$(3.22)(1.89) = 6.0858$
6	$(3.28)(1.89) = 6.1992$

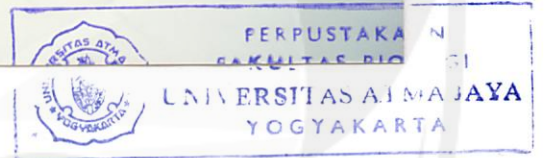
	6.1992	6.0858	5.9535	5.8023	5.5188	
	65.6	91.4	103.6	116.6	123.4	134.4
134.4	68.8	43	30.8	17.8	11	0
123.4	54.6	32	19.8	6.8	0	
116.6	51	25.2	13	0		
103.6	38	12.2	0			
91.4	25.8	0				
65.6	0					

Lampiran 8



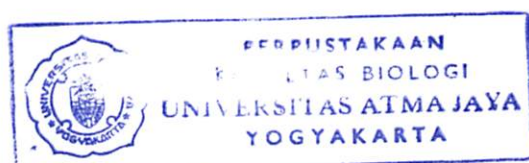
8. a Foto Daun Tanaman Kedelai Pada umur 2 Bulan

- A. Kontrol
- B. Pada konsentrasi 5 ppm
- C. Pada konsentrasi 10 ppm
- D. Pada konsentrasi 15 ppm
- E. Pada konsentrasi 20 ppm
- F. Pada konsentrasi 25 ppm



8. b Foto Akar Tanaman kedelai Berumur 2 Bulan (Panen)

- A. Kontrol
- B. Pada konsentrasi 5 ppm
- C. Pada konsentrasi 10 ppm
- D. Pada konsentrasi 15 ppm
- E. Pada konsentrasi 20 ppm
- F. Pada konsentrasi 25 ppm





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8. c Foto Tanaman Kedelai Berumur 2 Bulan (Panen)

- A. Kontrol
- B. Pada konsentrasi 5 ppm
- C. Pada konsentrasi 10 ppm
- D. Pada konsentrasi 15 ppm
- E. Pada konsentrasi 20 ppm
- F. Pada konsentrasi 25 ppm

DIREKTORAT JENDERAL GEOLOGI DAN SUMBERDAYA MINERAL
DIREKTORAT VULKANOLOGI
BALAI PENYELIDIKAN DAN PENGEMBANGAN TEKNOLOGI KEGUNUNGAPIAN
Jl. Cendana No. 15, Telp. (0274) 514180-514192, Fax 563630 Yogyakarta – 55166

LABORATORIUM KIMIA

Bentuk Conto : Jaringan Tanaman
Pengirim Conto : Kusumawati /Mhs. Atmajaya, Yogyakarta
Asal Conto :
No. Analisa : 04/02/LK/2001

HASIL ANALISIS KIMIA
(Dalam satuan ppm)

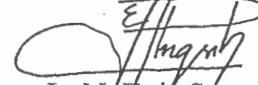
No	KODE	Cu	No	KODE	Cu
1	A-Ak	6,80	13	D-Ak	45,17
2	A-Bt	6,28	14	D-Bt	12,40
3	A-Dn	6,80	15	D-Dn	6,55
4	A-Bj	6,83	16	D-Bj	9,78
5	B-Ak	11,46	17	E-Ak	57,47
6	B-Bt	5,39	18	E-Bt	10,69
7	B-Dn	7,46	19	E-Dn	6,65
8	B-Bj	9,63	20	E-Bj	8,61
9	C-Ak	49,36	21	F-Ak	77,78
10	C-Bt	6,22	22	F-Bt	9,56
11	C-Dn	4,40	23	F-Dn	21,14
12	C-Bj	8,98	24	F-Bj	10,31

Keterangan :

Ak = akar
Bt = batang
Dn = daun
Bj = biji

Yogyakarta, 12 April 2001

Lab. Geokimia,



Ir. N. Euis Sutaningsih

NIP. 100010995

DIREKTORAT JENDERAL GEOLOGI DAN SUMBERDAYA MINERAL
DIREKTORAT VULKANOLOGI
BALAI PENYELIDIKAN DAN PENGEMBANGAN TEKNOLOGI KEGUNUNGAPIAN
Jl. Cendana No. 15, Telp. (0274) 514180-514192, Fax 563630 Yogyakarta – 55166

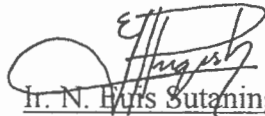
LABORATORIUM KIMIA

Bentuk Conto : Jaringan Tanaman
Pengirim Conto : Kusumawati /Mhs. Atmajaya, Yogyakarta
Asal Conto :
No. Analisa : 04/02/LK/2001

HASIL ANALISIS KIMIA
(Dalam satuan ppm)

KODE	Cu
Pasir	0,80

Yogyakarta, 6 Januari 2001
Lab. Geokimia,


H. N. Huts Sutarningsih
NIP. 100010995