CERTIFIED AGRICULTURAL IRRIGATION SPECIALIST

SAMPLE OF CAIS MATH QUESTIONS

THESE ARE IRRIGATION MANAGEMENT ORIENTED QUESTIONS THAT REQUIRE A GOOD UNDERSTANDING OF HOW AGRICULTURAL IRRIGATION IS DONE IN THE FIELD.

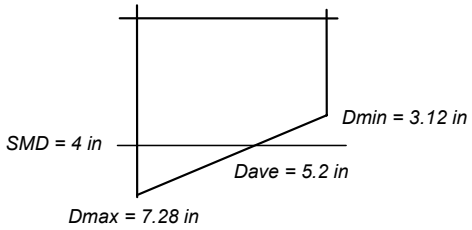
D 1. Given: Soil moisture depletion = 4 inches, Average infiltration = 5.2 inches, DUmin = 0.60.
How would you characterize the adequacy of irrigation on this field?

A) entire field is over irrigated
B) entire field is under irrigated
C) perfect irrigation timing
D) field has both under and over irrigation

SOLUTION

Note: the following example demonstrates how to construct and use Water Destination Diagrams. However, they simplify the procedure because they assume that the DU is not the DUlq, but rather a DU that uses the absolute minimum.

Dave = 5.2
Dmin = Dave x DU = 5.2 in x 0.60 = 3.12 in
Dave - Dmin = 5.2 in - 3.12 in = 2.08 in
Dmax = Dave + 2.08 in =5.2 in + 2.08 in = 7.28 in
Since SMD = 4 in,
SMD is between Dmin and Dave
=> some over irrigation, some under irrigation



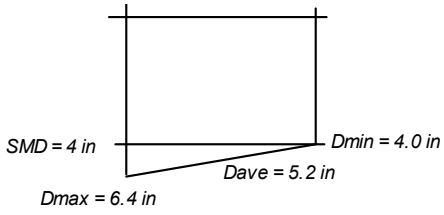
C 2. Given: Soil moisture depletion = 4 inches, Average infiltration = 5.2 inches, DU = 0.77.
How would you characterize the adequacy of irrigation on this field?

A) field is over irrigated
B) field is under irrigated
C) perfect irrigation timing
D) field has both under and over irrigation

SOLUTION

Note: the following example demonstrates how to construct and use Water Destination Diagrams. However, they simplify the procedure because they assume that the DU is not the DUlq, but rather a DU that uses the absolute minimum.

Dave = 5.2
Dmin = Dave x DU = 5.2 in x 0.77 = 4.0 in
Dave - Dmin = 5.2 in - 4.0 in = 1.2 in
Dmax = Dave + 1.2 in =5.2 in + 1.2 in = 6.4 in
Since SMD = 4 in,
SMD = Dmin => perfect irrigation timing



B 3. FC is 38%. What is FC in inches per foot?
A) 5.24 in/ft **B) 4.56 in/ft** C) 3.84 in/ft D) 3.16 in/ft

*38% x 12 in/ft = **4.56 in/ft***

D 4. PWP is 1.85 inches per foot. What if PWP in %?
A) 28.3 % B) 25.8 % C) 20.1 % **D) 15.4 %**

*1.85 in/ft ÷ 12 in/ft = **15.4%***

D 5. Clay soil, FC = 48%, PWP = 28% moisture by volume. What is AW (in/ft)?
A) 5.24 in/ft B) 4.56 in/ft C) 3.84 in/ft **D) 2.40 in/ft**

AW = FC - PWP = 48% - 28% = 20%
*20% x 12 in/ft = **2.40 in/ft***

A 6. Clay loam soil, PWP = 1.8 in/ft, AW =1.6 in/ft. What is FC (%)
A) 28.3 % B) 25.8 % C) 20.1 % D) 15.4 %

AW = FC - PWP => FC = PWP + AW
FC = 1.8 in/ft + 1.6 in/ft = 3.4 in/ft
*3.4 in/ft ÷ 12 in/ft = **28.3%***

A 7. Clay loam soil, saturation = 4.8 in/ft, AW = 1.6 in/ft, PWP = 2.0 in/ft, air dry = 1.5 in/ft. What is FC (in/ft)?
A) 3.6 in/ft B) 2.1 in/ft C) 1.6 in/ft D) 0.5 in/ft

AW = FC - PWP => FC = PWP + AW
*FC = 2.0 in/ft + 1.6 in/ft = **3.6 in/ft***

B 8. Same soil as in problem 7. What is the moisture content of the soil (%) if SMD = 0.5 in/ft?
A) 28.3 % **B) 25.8 %** C) 20.1 % D) 15.4 %

moisture content = FC - SMD = 3.6 in/ft - 0.5 in/ft = 3.1 in/ft
*3.1 in/ft ÷ 12 in/ft = **25.8%***

D 9. Clay loam soil, Saturation = 40%, FC = 28%, PWP = 16%, Air Dry = 13%. What is the SMD if the soil moisture content is 23% ?
A) 2.8 in/ft B) 1.4 in/ft c) 0.9 in/ft **D) 0.6 in/ft**

SMD = FC - moisture content = 28% - 23% = 5%
*5% x 12 in/ft = **0.6 in/ft***

D 10. Tomatoes with a 4 foot root zone are grown on a sandy loam soil. AW = 1.25 in/ft. ETc = 0.25 in/day, and the irrigation manager uses MAD = 60%. What is the total Plant Available Water for the root zone?
A) 1.5 inches B) 2.0 inches C) 3.0 inches **D) 5.0 inches**

*PAW = AW (in/ft) x RZ = 1.25 in/ft x 4 ft = **5.0 in***

C 11. How much rain (inches) will it take to penetrate 3 feet into the soil if the SMD is 0.5 in/ft?
A) 0.5 in B) 1.0 in **C) 1.5 in** D) 2.0 in

depth = rain ÷ SMD
*rain = depth x SMD = 3 ft x 0.5 in/ft = **1.5 in***

C 12. SMD totals 7.0 inches for a 36-inch root zone. How deep into the soil will 4.0 inches of water penetrate?.

A) 36 inches B) 7.0 inches **C) 20.5 inches** D) 4.0 inches

SMD = 7 in depletion ÷ 36 in RZ = 0.1944 in/in
depth = rain ÷ SMD = 4 in ÷ 0.1944 in/in = ***20.6 in***

Problems 13-16: Given: The following representative soil log for a field.

Soil Texture	Depth, in.	Zone Thickness, ft	AW, in/ft
Clay Loam	0-18"	1.5	2.00
Loam	18-36"	1.5	1.65
Sandy Loam	36-60"	2	1.25

D 13. Find the total PAW of the soil root zone for a crop with an effective rooting depth of 30 inches.

A) 1.75 in B) 2.69 in C) 3.33 in **D) 4.65 in**

0-18": 1.5 ft x 2.00 in/ft = 3.00 inches
18-30": 1.0 ft x 1.65 in/ft = 1.65 inches
Total: = ***4.65 inches***

D 14. Find the total AW of the soil root zone for a crop with an effective rooting depth of 48 inches.

A) 1.75 in B) 2.69 in C) 3.33 in **D) 6.73 in**

0-18": 1.5 ft x 2.00 in/ft = 3.00 inches
18-36": 1.5 ft x 1.65 in/ft = 2.48 inches
36-48": 1.0 ft x 1.25 in/ft = 1.25 inches
Total: = ***6.73 inches***

B 15. If RZ = 48 inches and MAD = 40%, what is the SMD just before irrigation?

A) 1.75 in **B) 2.69 in** C) 3.33 in D) 4.65 in

AW x MAD = Allowable Depletion
6.73 inches x 40% = ***2.69 in***

C 16. Same as problem 15. If the crop ET is 0.30 in/day, how many days between irrigations?

A) 5 days B) 7 days **C) 9 days** D) 11

time = amount ÷ rate
time = 2.69 in ÷ 0.30 in/day = ***8.97 days***

Problems 17-18: Assume wet soil evaporation according to the following curve (assume constant weather conditions):

Day	Stage	Evaporation rate (in/day)
day 1	stage 1	0.40 in/day
day 2	stage 2	0.28 in/day
day 3	stage 2	0.16 in/day
day 4	stage 2	0.04 in/day
day 5 and after	stage 2	none

C 17. A 10 acre field is irrigated with a microirrigation system once every 2 days. The microirrigation system wets 30% of the soil surface. What volume of water evaporates from the wet soil surface during a two-week period of irrigations?

A) 19.04 ac-in B) 16.02 ac-in **C) 14.28 ac-in** D) 8.80 ac-in

day 1 0.40 in x 10 acres x 30% = 1.2 ac-in
day 2 0.28 in x 10 acres x 30% = 0.84 ac-in
total = 2.04 ac-in for two days
for 14 days, this evaporation is repeated 7 times
total = 2.04 ac-in x 7 = ***14.28 ac-in*** *for 14 days*

D 18. A 10 acre field is irrigated with a level basin surface irrigation system once every 14 days. The level basin wets 95% of the soil surface. What volume of water evaporates from the wet soil surface during the two weeks after an irrigation?

A) 19.04 ac-in B) 16.02 ac-in C) 13.04 ac-in **D) 8.36 ac-in**

day 1 0.40 in x 10 acres x 95% = 3.80 ac-in
day 2 0.28 in x 10 acres x 95% = 2.66 ac-in
day3 0.16 in x 10 acres x 95% = 1.52 ac-in
day4 0.04 in x 10 acres x 95% = 0.38 ac-in
total = ***8.36 ac-in*** *for 14 days*

C 19. What pumping rate (cfs) is required to deliver 30 acre inches in 10 hours?

a) 2.4 cfs b) 2.4 cfs c) **3.0 cfs** d) 30 cfs
30 ac in/ 10 hr x 1 cfs/(ac in/hr) = ***3.0 cfs***

A 20. Given:
ECw = 0.2 dS/m
40 inches of applied water per year
40 ac
How many pounds of salt are applied per year? (1520)

A) 50,700 lbs B) 320,000 lbs C) 450,000 lbs D) 600,000 lbs

0.2 dS/m x 700 ppm/(dS/m) x lbs of salt/(1,000,000 lbs of water) x 40 in/(12in/ft) x 40 ac x 43560 sqft/ac x (62.4 lbs of water)/(cubic ft)
= 50,738 lbs

Problems 21-27. Irrigation Constraints

__**B**__ 21. A 140-acre field is irrigated with a center pivot irrigation system. The system operational time is 26 days a month, 18 hours a day. They system DU for the lowest quarter of the field is 0.90 and there is a 4% spray loss. If the peak ETc is 7.8 inches per month, find the gross GPM the irrigation system requires.

A) 1556 gpm **B) 1221 gpm** C) 2564 gpm D) 633 gpm

*Net gpm = (((7.8in/mth) / (26days/mth))/18hr/day) * ((140acres*43560sqft/acre)/96.3) = 1055 gpm*
AE = 0.9(1-(4%/100))*100 = 86.4%*
Gross GPM = (1055gpm/(86.4%/100))
= 1221 gpm

___**D**_22. A 140-acre field with a center pivot system that has a flow rate of 1300 gpm. The system has a DUlq of 0.85 and a 4% spray loss each irrigation. If the grower wishes to apply a net application of 0.4 inches each rotation, how many hours will the rotation take?

A) 12 hours B) 48 hours C) 35 hours **D) 24 hours**

Gross application = 0.4inches/(.85(4%/100)*100) = 0.49 inches/rotation*
*hours = (0.49inches * (140acres*43560sqft/acre)) / (1300gpm*96.3)*
= 23.9 hours

__**C**__23. A 140-acre field irrigated using a linear move irrigation system with a flow rate of 1000 gpm. The ETc for a certain month is 5.16 inches. The irrigation system is limited to running 18 hours a day 6 days a week and has an application efficiency of 80%. Find how many hours the system must run a month to meet the ET requirements.

A) 503 hours B) 278 hours **C) 409 hours** D) 396 hours

Gross inches = 5.16inches / (80%/100) = 6.45 inches
*Hours = (6.45*140acres*43560sqft/acre) / (1000gpm*96.3)*

*= 408.5 hours/month **(check if this is possible 4 weeks * 6 days * 18 hours = 468 hours/month possible run time, since the actual run time is less than the possible, the answer is possible.)*

__**A**__24. A 120-acre irrigated using microsprayers is split into 4 blocks. The system DUlq is 0.85 and pump flow rate is 1200 gpm. The peak ETc for a certain month is 7.59 inches. Because of the frequent wetting of a low volume irrigation system, it is necessary to increase the peak ETc by about 10% to account of increased evaporation and decreased crop stress. Find how many hours per month one emitter will be emitting water.

A) 111 hours B) 444 hours C) 356 hours D) 683 hours

*Adjusted ETc = 7.59 inches * (1+(10%/100)) = 8.35 inches*
Gross Adjusted ETc = 8.35/(0.85) = 9.8 inches
*Hours = (9.8 inches * 30 acres * 43560 sqft/acre) / (1200 gpm * 96.3)*
= 111 hours
(Because one microsprayer is running only as long as one block is running per month, we use 30 acres instead of 120 acres. If you were ask how many hours the pump was running per month, you would use 120 acres or multiply 111 hours by 4 blocks)

__**D**__25. A hand move sprinkler system with sprinkler spacing down the lateral of 30 feet and valve spacing on the mainline of 40 ft. The average sprinkler flow rate is 2.5 GPM. The lines are moved once a day with a one hour move time. The estimated DUlq is 0.75 and spray loss is 5%. Determine what the soil moisture depletion should be when the next line reaches that spot.

A) 4.65 inches B) 8.01 inches C) 2.65 inches **D) 3.28 inches**

*Gross inches applied = (2.5gpm * 96.3 * 23hrs) / (30' * 40') = 4.6 inches*
*Net inches applied = 4.6 inches * (.75 * (1-(5%/100)) **= 3.28 inches***
SMD = Net inches that are applied so that the soil can be refilled every irrigation.

__**B**__26. If from problem 25, the SMD was equal to 3.9 inches and the ETc rate in July was equal to 10.03 inches, what would be the frequency, in days, that one spot in the field would be irrigated.

A) 5.6 days **B) 12.1 days** C) 15.3 days D) 9.1 days

Frequency (days) = 3.9 inches / (10.03inches/month / 31 days/month)
= 12.1 days

__**C**__27. A 160 acre field is furrow irrigated. The furrow lengths are 880 ft with a 40 inch spacing. The field is supplied with 2000 GPM. It takes 9 days to irrigate the whole field with 8 hrs advance time (the time it takes for the irrigation water reach the end of the furrow). There is 100 acres per set. The estimated DUlq is 0.8 and runoff loss is 20% of the total applied. At the next irrigation the soil intake rate will be reduced by 15%. What is the optimum SMD at the next irrigation?

A) 4.55 inches B) 2.41 inches **C) 3.25 inches** D) 5.63 inches

*Total inches applied = (2000gpm * (9days*24hrs)*96.3) / (160acres * 43560sqft/acre) = 5.97inches*
*Average infiltrated = 5.97 inches * (1-(20%/100) = 4.78 inches*
*Minimum infiltrated = 0.8 * 4.78 inches = 3.82 inches*
*Minimum infiltrated next irrigation = 3.82inches * (1-(15%/100))*
= 3.25 inches