Wallace Laboratories

365 Coral Circle
El Segundo, CA 90245
Telephone (310) 615-0116 fax (310) 640-6863

Wallace Laboratories reaffirms our published statements that gypsum-treated soil can have as much as 25 percent to 100 percent more available water.

It is important to consider the fact that soils differ and that all soils are not responsive to gypsum but many are. Over 2.4 billion acres of the world's agricultural lands (40 percent of the total) can be improved with gypsum. Agriculture has failed to be sustainable several times in the history of the world because of soil failure (Rush 1987). Irrigated land eventually leads to sodicity and salinity unless extreme care is taken. Gypsum is a key ingredient for the maintenance of agriculture on many types of soils and over a wide pH range including sodicity. Regular use of gypsum is essential to the sustainability of most irrigated soils.

Shainberg, et. al., in 1989 extensively reviewed the use of gypsum in soil. I call your attention to several points discussed in that review.

1. On page 19 concerning swelling soils, gypsum indirectly increased soil porosity, structural stability, hydraulic properties, soil tilth, drainage and leaching, which all reduce dry soil strength. These factors all relate to water relations in soil to increase the amount of available water. Gypsum-treatment even slowed the rate of surface soil drying.
2. Page 20 states that water penetration and storage benefits have been described for many soils throughout the world as result of gypsum application.
3. Pages 23-25 discuss water penetration and water conservation under various infiltration rates. These rates were increased 2 to 4 times with gypsum application.
4. On page 41 more information was presented concerning about a 3-fold increase in infiltration and filtration rates.
5. On page 44 is a conclusion that gypsum application doubles the amount of water that entered soil.

6. Page 46 reports that gypsum application resulted in significantly less runoff.
7. On page 51 is a discussion of gypsum application resulting in greater hydraulic conductivity in the profile as well as a surface soil improvement.
8. Page 52 reports the findings that the percent seed emergence was enhanced with the application of gypsum. Plant germination was more uniformly spaced. Resulting increased yield can increase water-use efficiency because less water is needed per unit of yield.
9. Page 52 reports that gypsum-treated soil had lower evaporative water loss due to the crumbly soil surface which reduces the upward capillary water movement.
10. Page 52 also reports the decrease in bulk density of the gypsum-treated soil. It means that there is better soil aeration with better root development to result in ability of plants to use the water that is present.
11. On page 53, a 50 percent higher yield was experienced. The authors suggested that the reason can be a greater water supply. Other factors could be involved such as better soil aeration and also that more and deeper roots could use water more efficiently.

All of these items, although not uniformly applicable to all soil but in soils that are responsive to gypsum application, do suggest that more soil water can become available ranging from 25 to 100 percent.

Our statement that water-use efficiency can be increased is really obvious, but our statement does not give a quantitative value for the degree of increase in water-use efficiency due to the diversity of soils and other conditions.

Our literature and other research studies show that the use of polyacrylamide (PAM) soil conditioner has decreased water-use by up to 75 percent. Gypsum is expected do the same but with higher application rates than for PAM.

In our list of benefits for use of gypsum, several items relate to the water-use efficiency. See the enclosed.

I quoted reference from the California Agricultural 44(3) pg 10(199) by Jan W. Hopmans, Jim MacIntyre, and Randal J. Southard. “Water quality and subsurface soil variabilities affect infiltration”.

"Poor water penetration affects crop production on over 2.5 million acres of irrigated land in California." … "This can lead to the loss of large volumes of water to runoff."

One important researcher at the USDA Salinity in Riverside, California said that gypsum was greatly underused in California.

Arthur Wallace

Wallace Laboratories

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A summary

The conclusions of many studies around the world and conducted for various purposes is that the application of gypsum can result in increased availability of water in soil. It is obvious that:

Water application (rain or irrigation) minus runoff equals available water from infiltration. If gypsum decreases runoff and increases infiltration, more water accumulates in the soil.

[water addition *minus* runoff = infiltration or water added to soil]

OR

[water addition *minus* infiltration = runoff]

Gypsum decreases runoff because it increases water moving into the soil. Evaporation can result in some water loss but gypsum application can also decrease the amount of that loss.

Example of data (other data were given in the papers)

After reviewing many papers and other information, I concluded that with gypsum treatment, approximately 25 to 100 percent more water can become available to the soil profile. These values are interpretations of numerous reports. The above formula is not new in this simplified version but has been widely used for decades.

On page 25 of Shainberg, et al. and Fig 9, at 80 mm (3.15 inches) rainfall, the infiltration rate for the soil with ESP of 1.8 was 11 mm per hour with the addition of gypsum at 5 tons per acre. Without the addition of gypsum, the infiltration water was 3 mm per hour. Rain at the rate of 26 mm per hour had runoff at 15 mm per hour with gypsum and 23 mm per hour without gypsum. The efficiency of water availability was 42% with the addition of gypsum (11 mm per hour/26 mm per hour). The water efficiency was 12% (3 mm per hour/26 mm per hour) without gypsum. The infiltration rate was 400 percent greater with gypsum. The water use efficiency rate was also 400 percent greater (42%/12%).

Soil with ESP of 6.4 also at 80 mm, the gypsum resulted in 800 percent increase in infiltration. The infiltration rate was 8 mm per hour with the addition of gypsum at 5 tons per acre. Without the addition of gypsum, the infiltration water was 1 mm per hour. Rain at the rate of 26 mm per hour had runoff at 18 mm per hour with gypsum and 25 mm per hour without gypsum. The efficiency of water availability was 31% with the addition of gypsum (8 mm per hour/26 mm per hour). The water efficiency was 4% (1 mm per hour/26 mm per hour) without gypsum. The infiltration rate was 800 percent greater with gypsum. The water use efficiency rate was also 800 percent greater (31%/4%).

After 30 mm of rain, one set of data showed that gypsum treatment of soil had 100 percent greater infiltration and 400 percent increase in the other set.

The above illustrate the enhancement of water use efficiency with the addition of gypsum.

Other data show that gypsum can increase water infiltration on responsive soil by 100 percent or more. It was previously stated that 2 ½ million acres of farms in California had problems with infiltration of water including from irrigation.

On page 40 of that paper, runoff was decreased for different soils and in different years at 5 metric tons gypsum per hectare (2.23 tons per acre) in the following amounts. The data are in percents are: 70, 96, 47, 84, and 54. At 10 metric tons per hectare (4.46 tons per acre), there was even less run off. The average reduction was 70 percent. The range was 47 to 96 percent, close to the 25 to 100.

Simply, there is 70 percent less runoff and, more importantly, the 70 percent less runoff water is added to the soil for more available soil moisture. This value is between the 25 to 100 percent I gave as a general amount.

Some of the factors concerning these statements are in the attached excerpts.

A range of 25-100 percent more water in soil after water input is a conservative summary.

Summary

In conclusion, numerous controlled studies on the effects of gypsum application on soils responsive to gypsum support a conservative approximation that, as a result of increased infiltration and reduced run-off, there is 25% to 100% more water in the soil and therefore there is between 25% and 100% more available water for crop production.

POLYACRYLAMIDE (PAM) AND MICRONIZED PAM

SOIL CONDITIONERS

– 50 YEARS OF PROGRESS

2003

Arthur Wallace
Emeritus Professor, UCLA
Wallace Laboratories
Garn A. Wallace
Wallace Laboratories

Excerpts from Chapter 23 (pages 213-223)

Chapter 23- Gypsum Is Almost A Universal Soil Amendment

SOME REASONS FOR USING GYPSUM

Gypsum Improves Soil Structure.

Gypsum provides calcium which is needed to flocculate clays in acid and alkaline soil (Shainberg et al. 1989, Sumner 1993, Sumner and Miller 1992). It is the process in which many individual small clay particles are bound together to give much fewer but larger soil particles. Such flocculation is needed to give favorable soil structure for root growth and air and water movement.

Gypsum Prevents Crusting of Soil and Aids Seed Emergence.

Gypsum can decrease and prevent the crust formation on soil surfaces which result from raindrops or from sprinkler irrigation on unstable soil (Shainberg et al. 1989; Sumner and Miller 1992). It can even prevent crusting that results when acid soils are limed (Sumner 1993); the gypsum is coapplied with the lime. The gypsum is either surface applied or put on in the irrigation system. Prevention of crust formation means more seed emergence, more rapid seed emergence, and easily a few days sooner to harvest and market. Seed emergence has been increased often by 50 to 100 percent. The prevention of crusting in dispersive soils is a flocculation reaction.

Gypsum Improves Low-Solute Irrigation Water.

Gypsum is used to increase the solute concentration of low-solute water used for irrigation (Traynor 1980). Irrigation water from rivers that no longer have sources of leachable salts either penetrates poorly into soil or causes soil particles to degrade which results in low-water penetration. Rainwater can behave the same way and result in soil compaction. The problem can be corrected with surface-applied gypsum or application to the irrigation water.

Gypsum Improves Compacted Soil.

Gypsum can help break up compacted soil (Shainberg et al. 1989) and decrease penetrometer resistance (Hall et al. 1994a). Soil compaction can be prevented by not plowing or by not driving machinery on soil when it is too wet. The compaction in many, but not all, soils can be decreased with gypsum, especially when combined with deep tillage to break up the compaction. Combination with organic amendments also helps, especially in preventing return of the compaction.

Gypsum Stops Water Runoff and Erosion.

Gypsum improves water infiltration rates into soils and also the hydraulic conductivity of the soil (Shainberg et al. 1989). It is protection against excess water runoff from especially large storms that are accompanied with erosion.

Gypsum Improves Swelling Clays.

Gypsum can decrease the swelling and cracking associated with high levels of exchangeable sodium on the montmorillonite-type clays (Aldrich and Schoonover 1951). As sodium is replaced by calcium on these clays, they swell less and therefore do not easily clog the pore spaces through which air, water and roots move.

Gypsum Improves Water-Use Efficiency.

Gypsum increases water-use efficiency of crops. In areas and times of drought, this is extremely important. Improved water infiltration rates (Wildman et al. 1988), improved hydraulic conductivity of soil, better water storage in the soil all lead to deeper rooting and better water-use efficiency (Shainberg et al. 1989, Hall et al. 1994b). From 25 to 100 percent more water is often available in gypsum-treated soils than in nontreated soils.

Gypsum Decreases Bulk Density of Soil.

Gypsum-treated soil has a lower bulk density compared with untreated soil (Shainberg et al. 1989). Organics can even decrease it more when both are used. The softer soil is easier to till, and crops like it better.

Gypsum Can Increase Water Retention in Soil.

Gypsum when applied to sodic soil decreased levels of exchangeable sodium resulted in a large increase in water retention at a given tension compared with controls (Tiwara et al. 1993). Dry matter and seed yield were increased as a result.

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