Manure as Source of Nitrogen

studies of tilled and nontilled citrus and avocado orchards show manure to be efficient in supplying nitrogen to tilled soil

T. W. Embleton and W. W. Jones

Manure—an efficient source of phosphate and potash—is commonly used in California citrus and avocado orchards to supply organic matter to aid in maintaining soil in good tilth and to supply several fertilizer elements.

To determine the efficiency of manure as a source of nitrogen—in tilled and nontilled soils—four orchards were selected for study. A description of the experimental orchards appears in the large table on the next page.

Navels

A summary of the yield and nitrogen content of the leaves for Orchard *No. 1*—tilled navel oranges in Riverside County—is given in the table in the first column on page 15.

The trees that were never fertilized were practically nonproductive, and the nitrogen in the leaves was markedly lower than in the leaves of the trees fertilized with nitrogen. In this cultivated orchard there were no differences in yields between the trees receiving three pounds of nitrogen annually from calcium nitrate, and those receiving three pounds of nitrogen annually from manure. The amount of nitrogen in the leaves was practically the same for both sources of nitrogen. Thus, in this cultivated orchard, at the three-pound rate the results from manure paralleled those with calcium nitrate.

Valencias

In Orchard *No. 2*—nontilled Valencia oranges in San Diego County—withholding nitrogen since 1950 did not result in a significant reduction in yield, although a trend developed. In this nontilled orchard the trend was for the trees that received two pounds of nitrogen annually from manure to produce less fruit than the trees that received two pounds of nitrogen annually from ammonium nitrate.

The amount of nitrogen in the leaves of trees that received manure was definitely lower than in the leaves of trees that received ammonium nitrate.

When the spring flush of growth had fully expanded in 1954 and 1955, the leaves on the trees that did not receive nitrogen and on the trees that received manure were definitely more yellow than the leaves on trees that received ammonium nitrate.

In this nontilled orchard, manure did not supply nitrogen to the trees as efficiently as did ammonium nitrate. It is noteworthy that a large concentration of roots developed in the surface soil right

---

IRRIGATION

Continued from page 3

costs for the diesel plants were calculated on the basis of results obtained from measurements of the amount of fuel consumed during a field test and the total hours of operation.

Maintenance and attendance costs were based on the information supplied by the operators and are tabulated in the third column on page 3.

A summary of the mean, annual, fixed operating and total costs for each type of drive power in the three areas is given in the table in columns 1 and 2 on page 3. The variations in total cost for each type and group of pumping plants are the results of several important factors—total lift, hours of operation, total water pumped, and over-all efficiency of the plant.

The influence of the pumping lift on the total cost is indicated by a comparison of costs for the electric plants operating in the three areas of different water level conditions. The least cost, when compared on an acre-foot basis, is $3.92 for the Yolo electric plants which have an average pumping lift of 72′. The highest cost is for the Fresno plants—$12.25 per acre-foot based on an average pumping lift of 472′. However, if the comparison is made on a cost per acre-foot of per foot-of-lift basis, the order is reversed and the Fresno plants are the least expensive units and the Yolo plants the most costly.

Similar analysis can be applied to the relationship between the pumping lift and the total cost for each of the areas. For example, a change in pumping lift from 100′ to 200′ for the Riverside electric plants results in an increase in total cost per acre-foot from $5.80 to $8.28, or an increase of approximately 47%.

The more hours a pumping plant operates the less will be the annual total cost per acre-foot. This reflects a lower rate of depreciation, and in the case of an electrically driven plant, a lower energy charge as the hours of operation increase.

The over-all efficiency of the pumping plant has an important influence on the amount of fuel or power consumed. For example, a decrease in over-all efficiency of an electric plant from 70% to 50%—based on the data from the Yolo electric plants—while operating under the same conditions, increases the power cost 51%. A decrease in over-all efficiency from 15% to 12% for the natural gas plants increases the fuel cost 39% and 23% for diesel plants.

Maintaining the efficiency of a pumping plant at a high level may effect savings in power costs alone which will more than offset the annual depreciation charge for a new pump of higher efficiency or the maintenance of an older pump in good repair.

A comparison of the annual costs of diesel and electric plants in Yolo County showed that the operation of diesel plants is approximately 21% higher than the electric plants.

A similar comparison between the electric and natural gas plants of Riverside County shows that the pumping cost—per acre-foot—of electric plants is substantially higher than that of the natural gas. However, the lift, total hours of operation, and water discharge of the wells included are different in each group. However, an analysis—based on identical operating conditions with present-day electricity and natural gas schedules—gives the advantage in fixed and operating costs to the natural gas-powered pumping plants.

V. H. Scott is Assistant Professor of Irrigation, University of California, Davis.

N. L. McFarlane and Robert F. Kasmire, Farm Advisors, Riverside County, University of California, co-operated in the above-reported studies.

The above progress report is based on Research Project No. 779.

under the manure mulch. Similar root development did not occur where manure was not applied.

Avocados

In Orchard *No. 3*—tilled avocados in Ventura County—there were Hass, MacArthur, and Fuerte varieties in each of the experimental plots. In all treatments the amount of nitrogen in the leaves of the Fuerte and Hass varieties did not drop below 2.0%, while in the no-nitrogen plots the amount of nitrogen in the leaves of the MacArthur trees dropped to 1.60% in 1954. Only in the MacArthur variety were yield trends associated with the nitrogen treatments. Therefore, only the data from the MacArthur variety are presented in the lower small table in the next column.

The highest yields were from the plots from which nitrogen was withheld, and the lowest yields were from the trees that received one pound of nitrogen annually. The trees that received one half of a pound of nitrogen annually from either ammonium nitrate or manure were intermediate in both yield and in the amount of nitrogen in the leaves. However, the trees with the lowest amount of nitrogen in the leaves produced more fruit.

In this cultivated orchard, manure was as efficient as ammonium nitrate in supplying nitrogen to the trees. Equal amounts of nitrogen from manure and from ammonium nitrate produced similar levels of nitrogen in the leaves and similar yields.

In 1953 and 1954, in Orchard *No. 4*—nontilled Fuerte avocados in San Diego County—trees that received two pounds of nitrogen annually from ammonium nitrate produced less fruit than trees that received no nitrogen. However, in 1955 the trees that received nitrogen produced more fruit than trees that did not receive nitrogen.

Between treatments, the differences in the amounts of nitrogen in the leaves became greater each year. This appeared to be a case of going from an excess of nitrogen for production, to a deficiency.

In 1953 and 1954, the trees that received manure had yields that were similar to the yields from trees that had not received nitrogen; while in 1955 the manured trees produced about the same amount of fruit as the trees that received two pounds of nitrogen from ammonium nitrate. Every year, the amount of nitrogen in leaves from trees that received manure was closer to the level of nitrogen in leaves of trees that did not receive nitrogen, than it was to the level of nitrogen in leaves of trees that received nitrogen from ammonium nitrate.

Apparently the difference between 1.48% and 1.61% nitrogen in the leaves of the no-nitrogen and manure trees in September 1954 was great enough to result in rather wide differences in yield in 1955. In this nontilled orchard, manure was not as efficient in supplying nitrogen to the trees as was ammonium nitrate.

In these experiments, manure was an efficient source of phosphate and potash in both the tilled and nontilled orchards.

T. W. Embleton is Assistant Horticulturist, University of California, Riverside.

W. W. Jones is Horticulturist, University of California, Riverside.

The above progress report is based on Research Project Nos. 594, 1630, 1631.

Yield and Nitrogen Content of Leaves of Navel Orange Trees. Orchard No. 1, Cultivated.

No. trees in mean	Pounds N/tree/year	Source of N	Yield, lbs./tree, 1950	Nitrogen in leaves, % dry weight June '49	Oct. '49
		No Covercrop			
32	0	......	10	1.96	2.27
32	3	$Ca(NO_3)_2$	221	2.44	2.77
32	3	Manure	225	2.35	2.60
		Covercrop			
32	0	......	44	2.04	2.24
32	3	$Ca(NO_3)_2$	210	2.30	2.60
32	3	Manure	212	2.38	2.58

Yield and Nitrogen Content of Leaves of Valencia Orange Trees. Orchard No. 2, Nontilled

No. trees in mean	Pounds N/tree/year	Source of N	Yield, packed box equivalents per tree	Nitrogen in leaves, % dry weight	
			1955	Sept. '54	July '55
10	0	......	4.05	2.48	2.12
10	2	NH_4NO_3	4.72	2.76	2.62
20	2	Manure	4.25	2.56	2.41

Yield and Nitrogen Content of Leaves of MacArthur Avocado Trees. Orchard No. 3, Cultivated

No. trees in mean	Pounds N/tree/year	Source of N	Yield, lbs./tree	Nitrogen in leaves, % dry weight
			Av. '52–'54	July '54
8	0	......	104	1.60
8	0.5	NH_4NO_3	89	1.76
8	1	NH_4NO_3	74	2.00
8	0.5	Manure	82	1.70

Yield and Nitrogen Content of Leaves of Fuerte Avocado Trees. Orchard No. 4, Nontilled

No. trees in mean	Pounds N/tree/year	Source of N	Yield, lbs. per tree	Nitrogen in leaves, % dry weight
			1953	Oct. '52
30	0	......	54	1.79
30	2	NH_4NO_3	35	2.12
10	2	Manure	68	1.85
			1954	Aug. '53
30	0	......	85	1.60
30	2	NH_4NO_3	68	2.08
10	2	Manure	80	1.81
			1955	Sept. '54
30	0	......	104	1.48
30	2	NH_4NO_3	126	2.00
10	2	Manure	131	1.61

Description of the Experimental Orchards

Factor described	Orchard No. 1	Orchard No. 2	Orchard No. 3	Orchard No. 4
Location	Riverside County	San Diego County	Ventura County	San Diego County
Variety	Navel orange	Valencia orange	Hass, Fuerte and MacArthur avocados	Fuerte avocado
Year trees planted	1917	1925	1947	1939
Type of culture	Tilled, with and without winter cover crop	Nontilled	Tilled	Nontilled
Type of irrigation	Furrow	Sprinkler	Furrow	Sprinkler
Soil description	Medium texture, slightly alkaline, restricted water drainage	Light texture, acid, well-drained.	Medium texture, slightly alkaline, apparently well-drained.	Light texture, acid, well-drained.
Treatments compared	(a) No fertilizer, (b) 3 lbs. N/tree/year from calcium nitrate, (c) 3 lbs. N/tree/year from steer or dairy manure. Each treatment with and without cover crop.	(a) No nitrogen, (b) 2 lbs. N/tree/year from ammonium nitrate, (c) 2 lbs. N/tree/year from steer manure mulch. Each treatment had a basic application of phosphate from manure or treble superphosphate.	(a) No nitrogen, (b) ½ lb. N/tree/year from ammonium nitrate, (c) 1 lb. N/tree/year from ammonium nitrate, (d) ½ lb. N/tree/year from steer manure.	(a) No nitrogen since spring of 1950, (b) 2 lbs. N/tree/year from ammonium nitrate, (c) 2 lbs. N/tree/year from steer manure mulch.
Year differential treatments initiated	1927	1950	1951	1951