College of Tropical Agriculture and Human Resources
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# COVER CROP PLANT AVAILABLE NITROGEN (PAN) CALCULATOR

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USDA
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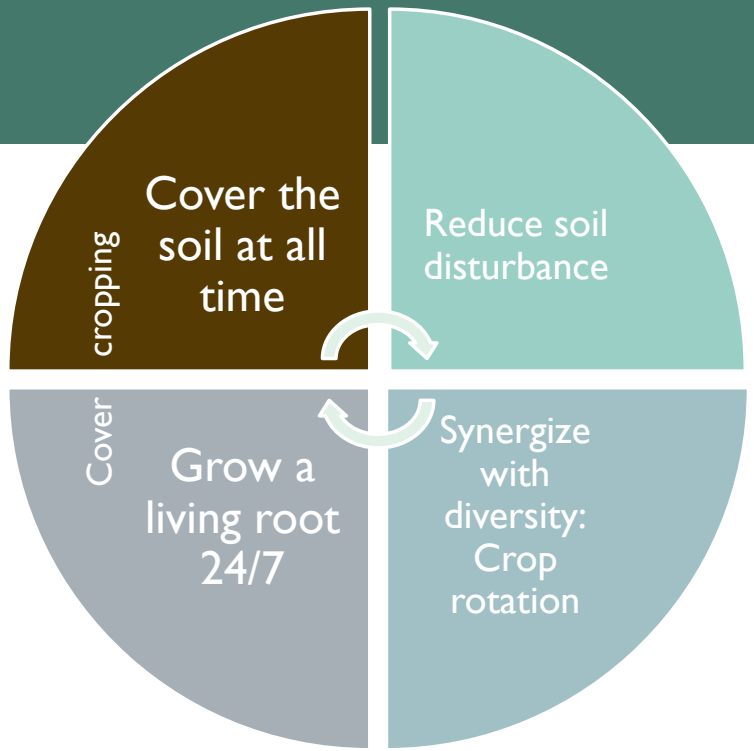
Year of Soils




unlock the SECRETS IN THE SOIL

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

# BENEFITS OF COVER CROPPING

1. Reduce fertilizer costs
2. Add organic matter
3. Improve yields by enhancing soil health
4. Reduce the need for herbicides and other pesticides (nematicide)
5. Prevent soil erosion
6. Conserve soil moisture
7. Protect water quality
8. Help safeguard personal health
9. Some cover crops offer harvest possibilities as forage, grazing or seed in multiple crop enterprises.

# SUMMER LEGUMES

- Leguminous cover crops can contribute significant amount of nitrogen to crop production. However, farmers need a better tool to accurately estimate the nitrogen contribution from legumes so as to precisely reduce fertilizer rates.


Sunn hemp

Cowpea


Lablab


Pigeon pea


Velvet bean

# WINTER LEGUMES

Woolypod vetch

Hairy vetch

Bell bean

Austria winter pea

White clover

# NON-LEGUMES

Annual ryegrass

Oat 'TAMU 406'

Sorghum sudangrass

Oil radish 'SodBuster'

# Cover Crop Chart for Hawaii

High Elevation → Low Elevation

Grass | Grass | Broad Leaves | Grass | Grass

Legume

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A Barley 70 lb/acre | | | | | | A Sesame 4 lb/acre R* | |
| A Cereal Rye 100 lb/acre | A Canola 15 lb/acre | B Yellow Sweet Clover 20 lb/acre | A Wolly pod Vetch 75 lb/acre | P Jack bean 50-60 lb/acre | A Cowpea ('CA Blackeye 5', 'Purple knuckle', 'TS Brown', 'MS Silver') 120 lb/acre R | A Buckwheat 90 lb/acre | A Pearl Millet 15 lb/acre |
| A Oat 90 lb/acre | A Mustard 15 lb/acre | P White Clover 15 lb/acre | A Hairy vetch 40 lb/acre | P Velvet Bean 40 lb/acre R* | A Soybean 50-75 lb/acre | A Mustard 15 lb/acre | A Oat 90 lb/acre |
| A Winter Wheat 120 lb/acre | A Rape Seed 15 lb/acre S | SP Red Clover 20 lb/acre | A Bell Bean 200 lb/acre | P Pigeon Pea 75 lb/acre | A/P Lablab 100 lb/acre | A Rape Seed 15 lb/acre S | A Black Oat 75 lb/acre |
| A Annual Ryegrass 100 lb/acre | A Oil Radish 10 lb/acre S | P Alfalfa ('Moapa 69') 20 lb/acre R | A Austrian Winter pea R | P Perennial Peanut R | A Sunn Hemp 75 lb/acre R* | A Oil Radish 10 lb/acre S | A Grain Sorghum 50-75 lb/acre |
| | | | | | | A Marigold 3 lb/acre R | A Sorghum-Sudangrass 50-75 lb/acre R |

**Nematode Resistant**

A = annual; B= Biennial; P = Perennial; SP = Short-term perennial.
R = resistant to root-knot but not reniform nematode; (note: only certain cultivars are resistant to root-knot nematodes for alfalfa and cowpea; cowpea is very susceptible to reniform nematode).
S = suppressive to plant-parasitic nematodes if soil incorporated.
R*= sunn hemp and velvetbean are resistant to root-knot and reniform nematodes; marigold, Tagetes patula is resistant to root-knot and reniform, *T. erecta* is only resistant to root-knot; sesame is resistant to southern and peanut root-knot nematode (*Meloidogyne incognita* and *M. arenaria*) but not Javanica root-knot (*M. javanica*).






# PLANT AVAILABLE NITROGEN (PAN)

- Although cover crops can fix or accumulate nitrogen (N) in plant tissues, not all the N in the tissue will be released into a plant available form.

At 28 days after cover crop incorporation
At 70 days after cover crop incorporation

$[NO_3^-]$

$[NO_3^-]$

**Plant Available Nitrogen (PAN %) = [Soil nitrate with cover crop (mg/kg) - soil nitrate without cover crop] X 100**
**Total N added by cover crop (mg/kg)**

% N in tissue × cover crop biomass = Total N

# FACTORS AFFECTING PAN% FROM COVER CROP

- climate conditions, season
- soil types
- cover crop species
- biomass, plant age, % N in tissue
- time after cover crop termination
- farming practices (till vs no-till)
- microbial activities in your soil

# PAN FROM COVER CROPS IN POAMOHO, OAHU (WINTER)

| Cover Cropping Practice | | | | Cover Crop Tissue | | | 28 Days | | 70 Days | |
|---|---|---|---|---|---|---|---|---|---|---|
| Season/tillage | Cover Crop | Fresh Weight ($lb/ft^2$) | Dry Content (%) | Dry Weight (lb/Acre) | Tissue N (%) | Total N(lb/A) | PAN (%) | Actual PAN (lb/A) | PAN (%)2 | Actual PAN(lb/A) |
| Winter/Till | Sunn hemp | 1.2 | 23.10% | 12074.83 | 1.66 | 200.44 | 55.24 | 110.72 | 67.82 | 135.94 |
| Winter/Till | Cowpea (Blackeye #5) | 1.04 | 13.70% | 6206.43 | 2.87 | 178.12 | 63.74 | 113.54 | 75.17 | 133.90 |
| Winter/Till | Lablab | 0.78 | 14.89% | 5059.15 | 2.75 | 139.13 | 62.72 | 87.26 | 75.22 | 104.65 |
| Winter/Till | Pigeon pea | 0.55 | 20.47% | 4904.20 | 3.47 | 170.18 | 66.14 | 112.55 | 81.69 | 139.02 |
| Winter/Till | Woolypod vetch | 0.55 | 9.21% | 2206.53 | 4.43 | 97.75 | 70.52 | 68.93 | 84.19 | 82.30 |

- % Tissue N varied among cover crop species.
- Total N from cover crop is based on biomass × % tissue N.
- Some cover crop released PAN more efficient than others (70.5% vs 55.2%).
- Actual PAN can be strongly influenced by cover crop biomass.

# CONVENTIONAL TILL vs NO-TILL

Till

No- Till

# PAN FROM COVER CROPS IN POAMOHO, OAHU (WINTER)

| Cover Cropping Practice | | | | Cover Crop Tissue | | | 28 Days | | 70 Days | |
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| Winter/Till | Woolypod vetch | 0.55 | 9.21% | 2206.53 | 4.43 | 97.75 | 70.52 | 68.93 | 84.19 | 82.30 |
| Winter/No-till | Sunn hemp | 1.07 | 24.62% | 11475.19 | 2 | 229.50 | 56.85 | 130.47 | 66.72 | 153.12 |
| Winter/No-till | Cowpea (Blackeye #5) | 1.47 | 14.20% | 9092.71 | 2 | 181.85 | 56.6 | 102.93 | 65.42 | 118.97 |
| Winter/No-till | Lablab | 1.02 | 16.20% | 7197.85 | 2.02 | 145.40 | 56.38 | 81.97 | 66.28 | 96.37 |
| Winter/No-till | Pigeon pea | 0.58 | 21.99% | 5555.73 | 2.31 | 128.34 | 60.11 | 77.14 | 67.32 | 86.40 |
| Winter/No-till | Woolypod vetch | 0.83 | 8.80% | 3181.62 | 2.92 | 92.90 | 62.08 | 57.67 | 70.43 | 65.43 |

- PAN % released was slightly reduced in no-till compared to tilled plots except for sunn hemp.

# PAN FROM COVER CROPS IN POAMOHO, OAHU (SUMMER)

| Cover Cropping Practice | | | | Cover Crop Tissue | | | 28 Days | | 70 Days | |
|---|---|---|---|---|---|---|---|---|---|---|
| Season/tillage | Cover Crop | Fresh Weight (lb/ft$^2$) | Dry Content (%) | Dry Weight (lb/Acre) | Tissue N (%) | Total N(lb/A) | PAN (%) | Actual PAN (lb/A) | PAN (%)2 | Actual PAN(lb/A) |
| Winter/No-till | Sunn hemp | 1.07 | 24.62% | 11475.19 | 2 | 229.50 | 56.85 | 130.47 | 66.72 | 153.12 |
| Winter/No-till | Cowpea (Blackeye #5) | 1.47 | 14.20% | 9092.71 | 2 | 181.85 | 56.6 | 102.93 | 65.42 | 118.97 |
| Summer | | | | | | | | | | |
| Summer/No-till | Sunn hemp | 0.72 | 21.34% | 6692.91 | 2.72 | 182.05 | 60.54 ✓ | 110.21 | 75.14 ✓ | 136.79 |
| Summer/No-till | Cowpea | 1.54 | 14.24% | 9552.53 | 2.83 | 270.34 | 67.57 ✓ | 182.67 | 74.43 ✓ | 201.21 |
| Summer/No-till | Lablab | 0.34 | 13.31% | 1971.26 | 3.13 | 61.70 | 78.05 | 48.16 | 81.91 | 50.54 |
| Summer/No-till | Sudex | 0.96 | 16.02% | 6699.18 | 1.33 | 89.10 | 43.48 | 38.74 | 54.95 | 48.96 |
| Summer/No-till | Oat (TAM406) | 0.51 | 14.72% | 3270.14 | 1.84 | 60.17 | 46.25 | 27.83 | 62.55 | 37.64 |
| Summer/No-till | Oil Radish | 0.55 | 6.40% | 1533.31 | 2.49 ✓ | 38.18 | 70.8 ✓ | 27.03 | 77 ✓ | 29.40 |

- PAN released % was higher in summer than winter.
- Grassy cover crops had lower % N and slower PAN released % compared to legumes, but those in oil radish are equivalent or higher than legumes.

# PAN FROM COVER CROPS IN LAULAMILO, HAWAII

| Cover Cropping Practice | | | | Cover Crop Tissue | | | 28 Days | | 70 Days | |
|---|---|---|---|---|---|---|---|---|---|---|
| Season/tillage | Cover Crop | Fresh Weight (lb/ft$^2$) | Dry Content (%) | Dry Weight (lb/Acre) | Tissue N (%) | Total N(lb/A) | PAN (%) | Actual PAN (lb/A) | PAN (%)2 | Actual PAN(lb/A) |
| Winter/Till | Bell bean | 0.78 | 10.60% | 3601.54 | 4.2 | 151.26 | 64.03 | 96.85 | 69.95 | 105.81 |
| Winter/Till | Austrian Winter Pea | 0.6 | 11.70% | 3057.91 | 4.9 | 149.84 | 63.34 | 94.91 | 67.72 | 101.47 |
| Winter/Till | Annual ryegrass | 0.36 | 13.42% | 2104.47 | 4.72 | 99.33 | 54.76 | 54.39 | 60.58 | 60.17 |
| Winter/Till | Woolypod vetch | 0.45 | 11.20% | 2195.42 | 5.32 | 116.80 | 58.46 | 68.28 | 66.57 | 77.75 |
| Winter/Till | Oat (Cayuse) | 1.15 | 17.20% | 8616.17 | 2.34 | 201.62 | 42.55 | 85.79 | 53.28 | 107.42 |

- PAN released % could change from location to location.
- Although N % in these cover crops were higher than the tropical legumes tested earlier, the actual PAN released were lower.
- Farmers could calculate amount of N fertilizer needed to full-fill the crop requirement.

| | | |
|---|---|---|
| Total N requirement for your crop: | A = | 180 |
| (Recommended by ADSC) | | |
| N available from your cover crop: | B = | 105 |
| Amount of N you need to fertilize for your crop: | | 75 |

# CONCLUSION

- ✓ Although PAN release rate at 70 days after cover crop termination were similar among all legumes and oil radish tested, actual PAN released varied mainly due to the biomass generated. **Thus, it is a good practice for farmers to estimate the cover crop biomass**.
- ✓ Graminaceous cover crops generally had lower PAN%, resulted in lower actual PAN regardless of the biomass generated. None-the-less, graminaceous cover crops are good nutrient scavenging crops, and soil C builders.
- ✓ Majority of the PAN were released during the first 28 days after cover crop termination, thus **additional fertilizer should be added there after.**