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Potato Cropping Rotations On Coarse-Textured Soils In Southeastern Idaho

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Crop rotations are a necessary part of soil management. They are needed to maintain productivity and favorable soil properties such as tilth, structure, and fertility, and to prevent buildup of disease-producing organisms. Rotation recommendations vary from area to area based on soil properties, climate, crops to be grown, and diseases likely to be encountered. In most of southern Idaho, alfalfa has historically been included in crop rotations because of its benefits to the soil. Since most operations were small family farms that included a livestock operation, hay fitted well into their farm operations.

In recent years, there has been a tendency toward larger acreages with more emphasis on cash crops such as potatoes and sugar beets. The absence of livestock in these operations eliminates the need for legumes, and the long-term nature of legumes discourages their use in rotations.

The generally accepted and recommended crop rotation practice in potato production is not more than one crop of potatoes in succession to avoid adverse effects on soil properties and a buildup of soil-borne pathogens. Based on this recommendation, the most intensive rotation presently recommended in potato production is alternate cropping to potatoes.

Extensive areas of coarse textured soils have come under cultivation in southeastern Idaho in recent years. The choice of crops that can be grown on these soils is limited by soil and climatic factors. In effect, to follow the policy that successive cropping to potatoes is not acceptable, growers are required to produce a cereal crop every other year.

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That cereal crop is generally considered to be a money-losing proposition on the coarse textured soils. Yields are minimal, even if the crop survives the generally unfavorable spring. Factors which limit yield are primarily management problems related to the coarse textures. Water holding capacities of these soils are very low, making irrigation timing and rates extremely critical.

Establishing the cereal crop in the spring is one of the biggest problems. Strong spring winds create severe erosion problems when the surface is not protected. Cereal crops must be planted in the spring because potato harvest takes place too late for fall planting. So the "blow-out" hazard is severe.

Since the cereal crop becomes an expense added to the cost of producing potatoes every other year, we need to evaluate the benefits of the cereal crop in the rotation and the effects of more frequent potato crops.

More frequent potato crops in the rotation generally create problems in soils by reducing soil organic matter, destroying soil structure, and adversely affecting other soil properties which create management problems. This is especially true on medium textured soils (loam and silt loam textured soils). However, on the coarse textured soils, neither organic matter nor soil structure changes would be serious problems. Warm soil temperatures cause a rapid decomposition of organic materials. Thus, soil organic matter on sandy soils is naturally low. Soil structure, the most easily degraded physical property of agricultural soils, is very weak or completely lacking in coarse textured soils. Thus, physical properties of these soils cannot be greatly affected by intensive cropping to potatoes.

Under a cropping program with successive years of potatoes, plant disease buildup might be the greatest problem encountered. Certain diseases can usually be avoided by planting certified potato seed as recommended by the University of Idaho. Early dying, one of the most important disease problems, can be controlled on a sandy soil by soil fumigation.* This practice also controls nematodes and some other pests.

Wind erosion, already a major problem on these soils, would become an even greater problem under a more intensive rotation.

Crop Rotation Study

A study was started in 1970 to evaluate various crop rotations on coarse textured soils. This study, conducted in the Fort Hall area of southeast Idaho, compares annual cropping to potatoes with various potato-grain rotations. The experiment included soil fumigation treatments to observe their influence on the buildup of soil-borne pathogens under the various rotations.

The plots were laid out in a complete random block design with four replications. Each plot is one sprinkler lateral wide (50 feet) and one-fourth mile (1320 feet) long. Eight crop rotation treatments are included (table 1). This trial had been planned for a minimum of seven years. The 1972 season was the fourth consecutive year in potatoes for the annual cropping treatments.

Data collected includes yield and quality of tubers harvested from each plot; specific gravity of tubers, and disease buildup as indicated by visual observations of top symptoms during the growing season.

Soils of the Study Area

This study is on Feltham loamy sand soils of the Fort Hall area in southeastern Idaho. Most of the experimental area has a slope under 2% although, in some areas, the slope ranges up to 5%. Some portions of the study area approach sand texture. The surface horizons have from 3 to 10% silt and 2 to 7% clay content. Sands, mostly medium and fine sands, range from 80 to 95%. The loamy sand textured profiles in the study area are predominantly over 6 feet deep, although some parts of the Fort Hall area have gravel within 3 feet of the surface.

There are approximately 16,000 acres of these coarse textured soils in the Fort Hall area and another 10,000 acres in the Michaud-American Falls area. The results of this study can be extrapolated to include all of these areas as well as other coarse textured soil areas used for potato production in Southern Idaho. The results may be extrapolated to include coarse sandy loam or loam textures bordering on loamy sand textures.

The results of this study are NOT applicable to loam or silt loam textured soils.

*Dallimore, C. E., Jay G. Garner, and R. E. Ohms. June 1967. Control of early dying of potatoes by soil fumigation. Idaho Current Information Series No. 52.

Table 1. Treatments comprising this Fort Hall rotation-fumigation trial.

	1969	1970	1971	1972	1973
1	P	G	P	G	P
2	P	G	PF	G	PF
3	P	P	G	P	P
4	P	PF	G	P	PF
5	P	G	G	P	G
6	P	P	P	P	P
7	P	PF	PF	PF	PF
8	P	PF	P	PF	P

P—Potatoes PF—Potatoes Fumigated G—Grain

Cropping History

The area used in this study was first brought under cultivation in 1967 and was planted to potatoes. In 1968, the area was planted to grain. In 1969, the entire area was again planted to potatoes. Although rotation plots were not established until 1970, the 1969 crop is considered to be the first year of the experiment.

Rotations

Four basic rotations have been included in these trials with additional fumigation making a total of eight treatments (table 1).

Treatment 1, alternate cropping to potatoes and grain, is the standard rotation presently used on these coarse textured soils. Under this rotation, the cropping is 50% potatoes. Treatment 3—two years of potatoes and one year of grain—increases potato cropping to 66.6% while treatment 5 includes potatoes only 33.3% of the time. Treatment 6 is 100% potatoes, or annual cropping to potatoes.

Cultural Practices

Soil fumigant treatments were applied by University of Idaho staff. Land preparation, irrigation, fertilization, and all other cultural practices were applied by the grower-cooperator.

The fumigant (dichloropropene-dichloropropane mixture*) was applied as early as possible in the spring, at least 2 weeks before planting. Treatments at the rate of 30 gpa were applied preplant broadcast with a chisel applicator. Chisels were 12 inches apart and the outlet was 10 to 12 inches below the surface.

Fertilization was adequate according to University of Idaho recommendations. Plots were planted at the farmer's convenience which generally coincided with the average planting date for the area. The average planting date for potatoes in this area is the end of April. All

*Shell D-D Commercial Product supplied by Shell Chemical Company.

irrigation was done with solid-set sprinklers. Harvesting was also done at the farmer's convenience somewhere near the last week of September or the first week of October.

Collecting Data

During the growing season, the potato plots were observed for differences in plant growth, amount of weeds, and symptoms of "early dying" or *Verticillium* wilt. No isolations were made from any plant tissue to determine what pathogens were present. Disease readings were confined to visual observations of "early dying" and ratings were made on the basis of an estimated percentage of dead plants (Barret-Horsefall ratings).

At harvest time, one truckload of potatoes was harvested from the center rows of each 50 x 1320 foot plot. The yield obtained from the plot and the size of the truck available determined the number of rows harvested. The area harvested was then measured so yield could be determined. The harvested sample was taken to a processing plant at Blackfoot and weighed. As the truck was unloaded, a grade sample was obtained by the Federal-State Inspection Service. Their grade for this sample, based on external quality, was used in evaluating the treatments. In 1972, additional samples of approximately 50 pounds were taken from each truckload for specific gravity determination.

Results

Yields

No yield data are available by plots for 1969, though all the area was planted to potatoes. Table 2 gives yield for each treatment as an average of four replications for 1970, 1971, and 1972. The lower yields in 1970 are attributable to an unfavorable cropping season in 1970 as well as improved cultural practices in 1971 and 1972.

Table 2. Total yield and percent U.S. No. 1 potatoes.

Treatment	1970 Yield	1970 No. 1's	1971 Yield	1971 No. 1's	1972 Yield	1972 No. 1's
	cwt/A	%	cwt/A	%	cwt/A	%
1	--	--	387	72	--	--
2	--	--	380	69	--	--
3	317	44	--	--	392	68
4	315	40	--	--	367	69
5	--	--	--	--	429	73
6	348	42	363	68	374	69
7	300	41	365	57	409	63
8	340	40	381	72	384	67
Average for year	322	41	375	68	393	68

Table 3. Specific gravity of 50 pounds of tubers from each plot in 1972.

	Replication I	II	III	IV	Average*
3	1.0773**	1.0785	1.0784	1.0749	1.0773
4	1.0753	1.0757	1.0772	1.0743	1.0756
5	1.0761	1.0802	1.0776	1.0783	1.0778
6	1.0779	1.0778**	1.0770	1.0769	1.0773
7	1.0770	1.0789	1.0797	1.0728	1.0771
8	1.0816	1.0794	1.0807	1.0777	1.0799
	1.0776	1.0785	1.0783	1.0758	1.0775

*Differences are not statistically significant.
**Calculated as missing plot.

This type of year-to-year variation is common in the study area because of uncontrolled elements or perhaps improper management. Comparison of treatments within a single year shows no differences in yield in any of the three seasons. The slight yield differences between treatments in any one year are not statistically significant.

For example, in comparing 1972 data, yield from plots annually cropped to potatoes without fumigation (treatment 6) is not significantly different from treatment 5—which in 1972 was cropped to potatoes following two years of grain. Nor is treatment 6 significantly different from treatment 7 which was annually cropped to potatoes with fumigation every year.

Quality

Percentage of U. S. No. 1's (table 2) also shows no apparent correlation between rotation or fumigation treatment and external quality or grade-out. Data collected on tuber size also showed no correlation to treatment. Although variations are evident from year to year in undersize tubers, oversize tubers and percent No. 1's, these differences cannot be related to treatments.

The results of specific gravity analysis of 1972 samples are given in table 3. These data show no significant differences in specific gravity caused by any of the treatments. There is as much variability between replications within treatments as there is between the averages for the six treatments. Thus, there is no evidence to support the commonly accepted theory that continuous cropping to potatoes causes lower specific gravity in tubers.

Disease

Early dying appeared sooner and became more severe in unfumigated plots than in fumigated plots. Plots that had been in potatoes continuously generally had more early dying than plots which included grain in the rotation. There was as much difference in early dying between replications of the same treatment as between different treatments. This can be attributed to field variability.

Conclusions and Recommendations

Coarse textured soils, such as the Feltham loamy sand soils of the Fort Hall area, are not subject to adverse physical property damage from annual cropping to potatoes. Coarse textured soils have little structure and are naturally low in organic matter content, nutrient and water holding capacities. Therefore, annual cropping would not greatly effect these properties. The major soil limitation under such a rotation would be wind erosion—a hazard which exists any time the surface is not protected.

Conclusions based on the data from this study are only preliminary. Conclusive recommendations will depend on more lengthy and extensive trials or field testing. However, our results to date do not support the commonly recommended practice of limiting potato production to not more than one year in succession on coarse textured soils. This does not apply to medium textured soils (loam and silt loam) and many sandy loam soils. Some sandy loam soils, including coarse sandy loams and sandy loams bordering on loamy sands, may be included.

Annual cropping to potatoes during the four years of this study has not significantly reduced potato yields or quality. More time is needed to evaluate fully the long-term effects of such a practice. One adverse effect would probably be a buildup in potato soil-borne pathogens. Although early dying symptoms increased in areas annually cropped to potatoes, yield or quality of tubers was not adversely affected.

Potato yields were just as good when potatoes were planted two years in a row followed by one crop of grain as when potatoes and grain were planted alternately.

Soil fumigation with dichloropropene-dichloropropane mixture has not significantly increased yields. The cost of fumigation would require a substantial yield increase to make this an economically feasible operation.

The data now available supports at least a potato-potato-grain rotation. However, because of potential disease buildup, we would not recommend long term mono-cropping to continuous potatoes based on the study to date.

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Control Weeds In Potatoes With Herbicides

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Cooperative Extension Service
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Weed-free rows in control plots are marked contrast to the uncontrolled plots in this experimental field.

Weeds Take $42 an Acre From Idaho Potato Growers

Uncontrolled weeds reduce Idaho potato yields an average of 11 sacks, or $20 per acre. Very weedy fields lose 35 sacks or more. A survey of 839 fields in Idaho showed that 56% had medium or heavy weed infestations. Cultivation for weed control is a general practice which in itself results in an average loss of 12½ or more sacks, or $22 per acre. Tests show that some growers lose 20% or more in yield, with quality loss too, because of cultivation. In short, uncontrolled weeds and cultivation for weed control are costing Idaho potato growers an average of $42 per acre or 13 million dollars a year. Better weed control practices can prevent or reduce these losses.

How to Use Herbicides For Potato Weed Control

1. Diagnose the weed problem.
   a. Find out what weeds are in your field. Herbicides are selective and, like medicines, are not cure-alls.
   b. Find out whether your weeds are susceptible to registered potato herbicides. Learn if they are seed-dependent annuals, or resistant perennials.
2. Plan the treatment well in advance to avoid possible complications.
   a. Choose a herbicide or combinations that will control all important weed species in your field.
   b. Determine exactly how the herbicide is to be applied and plan every detail into the cultural program.
   c. Plan to kill weeds before they grow beyond the seedling stage.
   d. Determine how this will affect other cultural operations and anticipate necessary changes in the usual procedures.
   e. Anticipate changes in equipment and learn any necessary special techniques and skills.
   f. Determine if additional treatments will be necessary.
   g. Know if following crops will be affected by herbicide use and if special efforts such as deep plowing will be needed to protect the next crop from traces of undecomposed herbicides.
   h. Find out from the label directions whether you can cultivate or operate equipment in the field after it is treated without jeopardizing weed control.
   i. Make final hill or other necessary surface conditioning to prepare for the herbicide application.
   j. Plan for proper soil moisture conditions to insure herbicide effectiveness. For some herbicides, you must be prepared to irrigate immediately after spraying.
   k. Plan to handle resistant perennial weeds as a separate problem.
3. Check out all application equipment.
   a. Check sprayer for proper operation: pump, screens, agitation system, connections and fittings, pressure regulator, gauges, nozzle tips. Inspect each tip to insure that all are the same size.
   b. Calibrate sprayer: calibrate each tip individually. Any tip should deliver within 10% of the rated average. Plan to use not less than 30 gallons of water per acre at 20-40 P.S.I. for adequate coverage of soil surface. Check your tractor speedometer/tachometer for accuracy. Don't assume it is correct.

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When You Use Herbicides

1. The directions are on the container label: learn and understand them. Use the directions given especially for potatoes.
2. In addition to the container directions, check the following keys to success for the usual situation:

Chemical Used	Rate of Active Ingredient Per Acre	Guides on Use and Keys to Success
Eptam	3 lb. EPTC (½ gal. Eptam 6E) 4 lb. EPTC for perennials (⅔ gal.)	Apply preplant or postplant* soil incorporated. All weed growth must be eliminated before or during incorporation. Effective to mid-season.
Treflan	½ to ¾ lb. trifluralin (1 to 1.5 pts. Treflan)	Postplant pre-emergence* - mechanical incorporation only, and before potato sprouts are 2″ long. Make final hill shape before spraying. If a sensitive crop is to follow, plow 10″ deep after potatoes. Effective entire season.
Treflan + Eptam	½ lb. + 2 lb. (1 pt. Treflan + ⅔ gal. Eptam)	Use same guide as for Treflan, above. Follow directions on **both** containers.
Lorox Maloran	1.5 to 2 lb. linuron (3-4 lb. Lorox) 2 to 3 lb. chlorobromuron (4 to 6 lbs. Maloran) Don't use on soils with less than 1% O.M.	These 2 are used for the same problems. Postplant pre-emergence* only; use only with sprinklers. Prepare final hill first because soil surface *must not* be cultivated or otherwise disturbed after spraying. Apply to moist, clod free soil with at least 30 gallons of water/A. One inch of water by rain or sprinkler must follow within 10 days to avoid wind blowing and to move the chemical to germination zone before weeds get too big. Effective all season.
Dinitro (salt formulation)	3 to 4.5 lb. (1 to 1.5 gal. of Premerge or Sinox PE)	Not for coarse textured soils (sands). Pre-emergence* only. Spray before potato sprouts are 2″ long. Don't disturb soil surface afterward. Kills emerged weeds and inhibits further germination for approximately 2 weeks.

*Preplant means spray on before planting potatoes. Postplant means spray on after planting potatoes. Pre-emergence means spray before potatoes come up.

c. Adjust and lubricate incorporation implements. If preparing to spray after planting and before potatoes emerge, insure that the incorporation implement teeth will mix the upper 2 to 4 inches of a pre-bedded potato hill on the proper row spacing.

d. Field test the entire mechanical assembly. Be sure that the entire tractor-drawn setup will be able to maintain a precise constant speed in the field to deliver the right gallonage. This is important for fields with slope. Changing gears or rpms can cause serious variations in rate.

e. Check your calculations!

What Cuts Yield and Grade?

1. Weed competition stunts potatoes. One study by the University of Idaho proved that the longer annual weeds were allowed to compete with potato plants the greater the yield loss. When weeds were allowed to compete for 60 days, the yield reduction was 48% compared with 2½% when competition was limited to only 15 days after potato emergence.
2. Poor cultivation practices injure potato plants.
3. Compaction from equipment stunts potato growth, reduces irrigation efficiency, and results in more clods.
4. Misused chemicals injure potatoes and following crops.
5. Weeds slow potato harvest and reseed to self-perpetuate and increase.

Prevent Reinfestation

1. Control weeds in all crops in the rotation to reduce seed supply in the soil.
2. Spray, burn, graze, or mow fence rows, roadways, ditches, and waste areas to prevent weeds from seeding.
3. Wash soil and trash from equipment coming from other farms or fields. These contain weed seeds.
4. Do not allow livestock to enter your land with weed seeds in hair, mud, or feces.
5. Plant only tested and tagged weed-free seed of all crops.
6. Screen irrigation water at headgates.

Perennial Weed Problems

Perennial weeds reduce yields more than annual weeds. Canada thistle can reduce yield as much as 70%, field bindweed 16%, and Russian knapweed 32%. Quackgrass will cause not only serious yield loss but also quality reduction from tuber deformation.

Growing potatoes in fields heavily infested with deep-rooted perennial weeds is not recommended. However, control programs have been developed to help a grower fight perennials in his potato production program.

Serious perennial weed problems must be solved with persistent programs over a period of years. See your county agricultural extension agent for recent publications on perennial weed control in certain crop situations:

C.I.S. No. 156, *Perennial Weed Control in Cereals*

C.I.S. No. 182, *Perennial Weed Control in Cultivated Crops*

C.I.S. No. 160, *Perennial Weed Control in Forage Crops*

The weedy shadow of an uncontrolled check plot in the center of this photograph is the only mar in this field of potatoes. Timely, careful herbicide use made the difference.

EFFECTIVENESS OF HERBICIDES IN IDAHO POTATOES
(This table applies only to conventional labeled usage in potatoes.)

Weed	Eptam	Treflan	Maloran and Lorox	Dinitro (Temporary Activity on Seedlings)	Fumigants (Telone, DD)
barnyard grass	A	A	A	O	
buckwheat	A	A	P	A	
cocklebur	O	O	O	P	
dodder	O	O	O	A	
foxtails	A	A	A	O	
knotweed	A	A	P	A	
kochia	O	A	P	A	
lambs-quarter	A	A	A	A	
mallow	O	O	P	A	
mustards	O	O	A	A	
nightshade	A	O	A	A	
purslane	A	A	A	O	
redroot	A	A	A	A	
Russian thistle	O	A	P	A	
sowthistle	P	O	P	A	
sunflower	O	O	O	P	
sweetclover	O	O	A	O	
volunteer barley	A	O	O	O	
volunteer oats	A	A	O	A	
volunteer wheat	A	P	A	O	
wild oats	A	P	O	O	
Canada thistle	O	O	O	O	A
morning glory	O	O	O	O	A
nutgrass	A	O	O	O	P
quackgrass	A	O	O	O	A
Russian knapweed	O	O	O	O	

*Key: Acceptable control A
Partial control P
No control O

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