VEGETATION MANAGEMENT EFFECTS ON FRUIT TREES

by

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VEGETATION MANAGEMENT EFFECTS ON TREE GROWTH: AN OVERVIEW

INTRODUCTION

The orchard floor is managed to provide satisfactory conditions for root growth and a suitable surface for the passage of machinery. The particular system to achieve this aim varies with the topography of the land and climate. Currently, there are several orchard management systems in use: cultivation, strip herbicide, overall herbicide, cover crops, and mulches. Soil management practices significantly influence the growth and subsequent yield of apple trees (*Malus sylvestris* Mill.) through their effect on soil properties, moisture, nutrient availability, beneficial soil fauna, pest/predator complexes, possible allelopathic effects, and the host nutritional status.

LITERATURE REVIEW

Soil Properties

The soil structure is determined by the size and distribution of soil particles called peds (17). Adequate pore space between soil aggregates is essential for air and water infiltration. The roots of cover crops influence pore size and distribution by creating tunnels and physically pushing soil aggregates apart (75). These pores are stabilized by microbial polysaccharide gums when the roots die (63). As the cover crop extracts water from the soil, the roots shrink and additional cracks are formed. Cover crop roots provide a continuous source of organic matter to the soil which increases aggregate stability (25). Miller and Kemper (58) report a single application of decomposable organic material resulted in stable aggregates. Childers (26) notes that grass sod, the most common cover crop, generally results in a friable, stable well-structured soil with satisfactory water retention, aeration, and infiltration properties.

Cultivation loosens soil clods, resulting in greater porosity in comparison to grass sod in the short term (46). However, in the long term, the number of stable soil aggregates is decreased, largely due to rapid decomposition of organic matter (17). Water infiltration and aeration are further reduced because of the formation of crusts on the cultivated soil. Kenworthy (48) reported greater erosion on cultivated soils than grass covered soils. For similar reasons, an overall herbicide system can result in soil erosion on sloping land. This was evident from a survey of growers: 37% of the growers who used this system suffered some erosion with 11% of these experiencing serious erosion.

Herbicide treatment results in a more tightly packed soil with decreased total porosity (46). However, increased soil densities occur only to a depth of 15 to 20 cm. and some researchers feel there is a greater continuity of pores under herbicide treatments (13). In a 14-year experiment, Robinson and O'Kennedy (72) did not find the expected soil structure deterioration under the overall herbicide treatments. The presence of a moss cover probably protected the soil from the full impact of the rain. Improved water penetration occurred through cracks, in a four-year study of an overall herbicide system (19).

Mulches maintain the structural stability of the soil by maintaining organic matter and absorbing the impact of the raindrops, thus increasing water infiltration.

Moisture Availability

A study conducted in southern Ontario to assess the effects of soil, climatic, and management factors on apple production determined the most important soil variables were related to drainage and water retention properties (95). The texture, structure, and organic matter content of the soil all influence the quantity of water available to the tree. Much of the benefit of organic matter is the result of its favorable influence on soil structure, and in turn soil porosity (22). Soil management practices influence moisture availability both through their effect on the physical properties of the soil, which determine the rate of water infiltration and absorption, and through cover crop competition. Within a short time frame , cover crops reduce the quantity of water available for the trees. In dry summers, irrigation is essential with a sod management system to prevent severe growth restrictions (43,97). Mulches increase the percent available moisture by reducing evaporative loss and shielding the soil surface from drying winds (17). Dancer (30) found the available moisture was greatest under a mulched soil, intermediate on a cultivated soil, and least under three covercrops, timothy (*Phleum pratense* L.), rye (*Secale cereale* L.), and red clover (*Trifolium pratense* L.). Several studies indicate herbicides increase the amount of moisture by decreasing weed competition. A comparison of a complete sod treatment with a herbicide strip treatment showed the former was significantly drier (101). In another study, the lowest moisture deficit occurred in the overall bare treatment. Baxter (18), however, found no difference in the moisture content of sod and herbicide plots in a dry season.

The importance of adequate soil moisture is evident from a study comparing early, late, and no irrigation treatments. Late irrigation increased the two highest quality grades of fruit by 67% over the unirrigated trees (36).

On heavy clay soils with inadequate drainage, cover crops help reduce tree death from waterlogging (20). The use of a mulch under these conditions has led to the death of peach trees (*Prunus persica* (L.) Batsch) from either high water infiltration rates or the formation of impermeable layers that restricted air access to tree roots (20,27).

The moisture capacity of the soil varies with the different soil management programs. In long term studies, a grass sod often increased the soil's moisture capacity through reduced runoff (48). Continued cultivation resulted in degradation of the soil structure, increased surface runoff and a reduced moisture storage capacity. Cultivation increases the bulk density of the soil. One researcher reported the bulk density of a cultivated, six-month-old orchard soil increased to that of the soil of a 12-year-old orchard under continuous herbicides (12). Bulk density is determined by the quantity of pore space as well as soil solids. Thus, soils that are loose and porous will have lower bulk densities. Other studies also show that herbicide use does not appear to be as detrimental to soil structure, and subsequently water-holding capacity, if a mulch is periodically applied. The mulch slows the rate of organic matter decomposition. Childers (26) found that the application of a manure mulch each winter to a herbicide treated plot significantly increased the infiltration capacity over the herbicide alone plot.

Nutrient Availability

Soil management, by its effect on soil organic matter, mineral cycling, interspecific competition and tree root distribution can affect the availability of soil nutrients to orchard trees. The beneficial effect of organic matter is the result of its colloidal nature. The capacity of organic matter to hold water and nutrient ions is far greater than that of clay (22). This is reflected in a reduced leaching loss under sod for calcium, magnesium, potassium, phosphorus, ammonium, and nitrate (54).

Groundcovers may also serve an important role in the mineralization and subsequent recycling of nutrients (41,92). Much of the fertilizer applied to a grass orchard floor, was initially used by the covercrop. However, rapid cycling of many of the cations, potassium for example, occured when the mown grass was left to decompose (99). Perring (64) noted the presence of a grass covercrop in the absence of applied potassium, raised the potassium concentration in the fruit and leaves. For elements such as phosphorus, which are rapidly fixed in unavailable forms in the soil, the use of the phosphorus fertilizer by the grass, subsequent mineralization, and release following mowing can provide the tree with a steady supply of this element in an available form (16,44). The work of Ferauge and Krotoszyner (34) illustrates this. A covercrop of clover or rye significantly increased the total P content of 'Golden Delicious' apple trees in comparison to the bare ground treatment. Cornish and Raison (28) provided evidence of nitrogen cycling under a grass covercrop. Soils collected from native pastures showed very slow rates of nitrogen mineralization under favorable laboratory conditions. However, in the field, grasses absorb 40 kg N/ha/year. This indicates the mineralization of organic nitrogen was stimulated by the plants.

Soil pH largely determines the availability of plant nutrients. The use of some herbicides has led to a drop in soil pH, as a result of an increased leaching of bases and a reduction in earthworm activity (14,96). G. C. White (100) reported mean pH values of 4.96 with the overall grass system, 4.44 when paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) was used and 4.33 when the plots were treated with simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) overall. Higher rates of nitrogen fertilizer were associated with greater soil pH differences between the herbicide-treated areas and the alleys seeded to grass. The largest differences in soil pH occurred in the top 0-15 cm of soil. Atkinson (7) found the pH under a simazine treated strip, in a 0-15 cm depth, was 5.2 in comparison to 6.1 at a 15-30 cm depth. The soil pH under the grass system was 6.1 and 6.2 for the two soil depths. Banwell (15) similarly recorded pH values of 4.3-5.0 in the top 0-7.6 cm of simazine-treated soil. Increased soil acidity is common with simazine use, but not inevitable. Atkinson and White (9) found no change in the soil acidity in a five-year-old orchard under overall herbicide management. He also recorded satisfactory pH values of 7.4 in the 0-15 cm depth range under a simazine-treated herbicide strip in a new planting of apples (7). The difference in these results may be due to the original soil pH, the amount of lime applied, and the number of years the soil remained free of vegetation.

To avoid reductions in tree growth, sufficient fertilizer must be provided to satisfy the covercrop requirement. Bould and Jarrett (21) found significant growth responses to additional nitrogen fertilizer for young trees on timothy and rye plots. They recommend that the application of nitrogenous fertilizer be adjusted to maintain a leaf-nitrogen concentration of at least 2% dry matter.

The competitive advantage of grass stemmed from its small potassium requirement and earlier, rapid growth in the spring (70). Differences in fertilizer consumption under the herbicide strip systems and sod systems reflect the additional nutrients needed to satisfy interspecific competition (32).

A cultivated system also required a greater amount of fertilizer than a herbicide strip system. Cultivation harmed the surface roots that would otherwise exploit the plentiful surface nutrients. Stronger root systems with subsequent greater nutrient uptake were also attributed to the greater quantity of available water under the herbicide strips (6,11). Even under established trees, most of the roots are confined to the treated strip. The authors of one study reported the heaviest root system occurred under a sod groundcover, irrigated system; a herbicide strip treatment gave an intermediate response; the smallest root system occurred on trees grown under a sod system. Grass competition promoted a deeper root system which required a greater proportion of the tree's reserves (10).

The soil management system affects fruit quality through the availabilty of particular nutrients (68). A low concentration of phosphorus or calcium in the fruit was associated with an increasing incidence of fruit breakdown during storage (65,78). Herbicide use in place of grass can lead to a drop in soil pH as previously mentioned, with a subsequent high soil K/Ca ratio (10, 15). Lovelidge (53) and Delver (32) reported an increased incidence of bitterpit for trees grown under a herbicide management system. This appeared to be the result of higher than normal potassium concentrations in the soil and foliage of the trees on the herbicide treated plots. Fruit calcium levels have been negatively correlated with mean fruit size (47). Fruit size is often smaller with the use of herbicides as a result of the increased availability of nitrogen and subsequently larger yield. Thus, if the soil was not acidic, herbicide treatments were beneficial to fruit quality.

Bitterpit is only one of a number of fruit quality factors. Fruit quality characteristics such as soluble solids, acid content, texture, and color were detrimentally affected by herbicides (38). This detrimental effect was the result of heavier yields under the herbicide system leading to a reduced leaf/fruit ratio. Some researchers have noted the association of good fruit color with a covercrop (47,84).

Soil Fauna

Earthworms are important both for their effect on soil structure and soil pH. Their numbers are much higher under a covercrop which provides them with a source of food (2,88). Their burrowing action increases soil aeration, as well as transporting organic matter to the lower soil layers (22). The casts of these organisms are much higher in organic matter, bacteria, exchangeable calcium, magnesium, phosphorus, potassium, and nitrogen than the surrounding soil. Earthworms raise the soil pH through the secretion of calcium compounds from their calciferous glands (96). In laboratory studies, Leger and Millette (51) found earthworm activities raised the soil pH by as much as one pH unit in 100 days. Low soil ph has been associated with decreased fruit storage potential, as noted earlier, as well as manganese toxicity (15). The reported reduction in pH under simazine treated plots could reflect smaller earthworm populations (15). A more favorable habitat can be created for earthworms with the addition of a mulch to herbicide-treated soil. The mulch provides a source of food and also regulates soil temperature and moisture. The addition of a straw mulch to cultivated soil increased earthworm populations up to 8 kg/ha (86).

For similar reasons as noted with earthworms, covercrops and mulches enhance microbial populations in the soil. The decomposition products of these organisms, as well as the fungal mycelium itself, serve to act as a cementing agent for the soil aggregates. Microorganisms also perform varied processes such as organic matter decompostion and nitrogen transformation. Herbicides affect microbial life indirectly through the reduction in the quantity of organic matter (40,42). Mycorrhizal infections were often higher under grass than a herbicide treatment, because the infection occurred from root to root contact rather than from germinating spores (10). Consequently, there were greater infection rates where grass and apple roots were intertwined. Nye and Tinker (62) suggest a mycorrhiza association can result in a six-fold increase in phosphate supply to the tree. Herbicide use may affect root microflora through an influence on root morphology and physiology (40).

The net effect of cultivation on soil fauna is detrimental (96). The removal of a covercrop exposes the upper layers to greater extremes in temperature and moisture. Cultivation results in a high mortality rate among larger soil fauna. Baeumer and Bakermans (14) found only half as many earthworms on tilled as untilled plots after a seven year experiment. Similiarly, Raw and Burges (69) showed the total arthopod population under a cultivated soil was only one-tenth that of a plot seeded with grass.

Pest/Predator Complex

In recent years researchers have recognized that the orchard soil environment influences both beneficial and pest species populations. Integrated pest management programs can be designed to take advantage of interactions between the abiotic and biotic factors. The goal of such a program is to control pests in an economically and environmentally sound fashion.

A soil management system can affect both the pest and beneficial predator and parasite populations through the destruction or enhancement of the organism's habitat. Treating the entire orchard floor with herbicides destroyed the overwintering sites of the green peach aphid, (*Myzus persica* Sulzer), reducing its population (93). Cultivation of the orchard floor reduced vole (*Microtus pinetorum*) numbers for a limited period of time by destroying surface tunnels, killing the animals outright, and reducing the weed populations that served as a food source (24). A combination of cultivation and residual herbicides has given satisfactory vole control in some orchards (24). Many weeds and certain covercrops such as orchardgrass (*Dactylis glomerata* L.) serve as alternate hosts for nematodes (57). This may not be entirely detrimental. Hoestra and Oostenbrink (45) found that a grass covercrop was a more efficient host for the root lesion nematodes (*Pratylenchus penetrans* Filipjev) and ,thus, may decrease the infestation of apple roots. However, it is generally recommended that covercrops known to enhance nematode reproduction be avoided as the last crop prior to planting the orchard. Red clover is one example.

Although the removal of cover crops and weed species can reduce certain pest species, it may have a detrimental effect on predator and parasite populations. Cover crops served as overwintering and early feeding sites for predacious mites (5). The reproductive capacity of parasites of the San Jose scale (*Quadraspidiotus perniciosus* Comstock) was increased when nectar-bearing cover crops were present as supplementary food sources (39). A program in

New Zealand utilized cover crops as overwintering sites for parasites of the light brown apple moth (*Austrotortrix postvittana* Walker) (61). Much greater control of the oriental fruit moth (*Grapholita molesta* Busck) has been achieved when a certain number of weed species were left to serve as alternate hosts for the parasites (31). Greater parasitism of the codling moth (*Cydia pomonella* L.) has also been noted in orchards with some weed species present (31). Cover crops are reported to promote effective predation and parasitism by reducing dust in the orchard (94). Several genera of fungi and bacteria prey upon nematodes, in particular the fungus genus *Seinura* (60). Populations of these predatory microorganisms were higher in an orchard seeded with grass.

Allelopathic Effects

Cover crops may be utilized for their allelopathic properties to reduce weed populations. Putnam and DeFrank (67) found that specific varieties of grain sorghum (*Sorghum bicolor* (L.) Moench) mulches ('Bird-a-Boo' sorghum and 'Monarch' sudangrass) suppressed weed populations 90% and 85%, respectively. Fall-killed 'Balboa' rye similiarly reduced weed populatins by 88%. Most of the weeds present in this trial were annuals and included common lambsquarters

(*Chenopodium album* L.), common ragweed (*Ambrosia artemisiifolia* L.), large crabgrss (*Digitaria sanquinalis* Scop.), and green foxtail (*Setaria viridis* (L.) Beauv.). More extensive tests with perennial species are needed. Allelopathy may also be important in a different aspect. Toxic compounds of plant origin tend to accumulate in the soil around perennial crops. Microbial populations, which are enhanced under a covercrop, may prove beneficial for an orchard because they are capable of metabolizing the toxins (66).

Host Nutritional Status

Soil management may affect pest population densities through its effect on the host tree's nutritional status. Perring (64) reported that the use of a grass cover crop in the absence of applied potassium, invariably raised the potassium concentration in the leaves and fruit. Kirkpatrick et al. (49) found trees with a high K status had the lowest populations of the dagger (*Xiphenema americanum* Cobb) and root lesion nematodes. Excessive nitrogen, resulting in late season succulent growth and higher nitrogen foliage levels, created optimum conditions for several insects: the pear psylla (*Psylla pyricola* Foester), the apple aphid (*Aphis pomi* Degreer), the oriental fruit moth of peaches (Grapholita molesta Busck), and red mites (Family: Tetranychidae) (44). The positive correlation between nitrogen level and mite numbers is primarily the result of increased fecundity.

The frequency of disease was similiarly affected by the soil management system. Montgomery and Wilkinson (59) consistently found fewer storage disorders from fungus caused rots (Gloesporium cingulatum Atk.) in fruit grown on grass sods. This was thought to be the result of a competition for nitrogen from the covercrop. Schmidle et al. (77) found increased nitrogen and potassium levels in the foliage of trees grown on cultivated plots. Tillage and high soil nitrogen levels have been shown to favor the development of powdery mildews (Podosphaera leucotricha Salm.) (102,103). As a result of increased mud splash, cultivated or overall herbicide plots often have a higher incidence of trunk rot of apple, associated with the fungus, Phytophthora cactorum Leb.& Cohn (72). As noted earlier, the use of a herbicide may cause a drop in soil pH. Tissue breakdown following manganese toxicity on these acid soils, provides an entry site for the fungus Nectria galligena Bres., the pathogen of the nectria cankor (15).

SUMMARY

From a brief review of the literature, the various orchard soil management systems have both beneficial and detrimental effects. Cover crops and mulches improve soil structure through the addition of organic matter resulting in better aeration, water infiltration and nutrient retention. On rolling topography they aid in erosion control. Earthworms and microbial populations increase with the addition of organic matter that serves as a food source, as well as moderates soil moisture and soil temperature. Pests, as well as parasites and predators overwinter and feed on cover crop vegetation. Allelopathic cover crops suppress weed populations. The incidence of several diseases, caused by the fungus pathogens, are lower under a cover crop system.

To obtain the beneficial effects of cover crops it is necessary to irrigate in dry seasons and fertilize during groundcover establishment. The removal of noncrop vegetation with either cultivation or herbicides is thought to benefit tree growth by reducing competition for water and nutrients. Herbicide use is favored because it does not appear to be detrimental to the soil structure, except when used for long periods of time without the addition of

organic matter. The use of a chemical also enables the grower to control weeds without disturbing the surface root system. Properly selected herbicides can give residual weed control.

PART II

EFFECT OF SELECTED PREEMERGENCE HERBICIDES ON EARLY SEASON WEED CONTROL AND SHOOT GROWTH OF NEWLY PLANTED APPLES AND PEACHES

INTRODUCTION

Many studies with young fruit show the removal of the cover crop and weed population from around the base of the tree results in greater tree growth and short-term productivity. The amount of weed growth was directly related to shoot extension of young trees (35). The effect on growth was greatest the first year of the tree's life, but continued until the fourth season (56). Even a partial weed cover detrimentally affected a young trees size for a number of years (101). The trunk girth of seedling trees maintained on a one-square meter weed-free block was twice that of trees on weedy plots.

Detrimental effects on growth from weeds or covercrops are attributed to competition for either soil nitrogen or moisture. In areas of adequate rainfall, competition for nitrogen is considered the primary limiting factor (37,83). The competitive effect of a covercrop is related to its rooting vigor. Bould and Jarret (21) found perennial ryegrass (Lolium perenne L.) was the most competitive of those tested, followed by timothy and the indigenous grasses (Poa annua L. and Agrostis stolonifera L.). The timothy and perennial ryegrass severely restricted growth until the fourth season, at which time the leaf nitrogen status was normal. The indigenous grass mixture and white clover (*Trifolium repens* L.) had no suppressing effects on growth. Stott (83) similarly found growth unaffected by a white clover crop after the first year of establishment.

The length of time a competitive covercrop checks tree growth may be substantial. One study indicated a period of eight years, although by the fourteenth year, the size of the trees on the covercrop plots equalled those under a cultivation or mulch treatment (35). Apple varieties vary in their tolerance to competition from covercrops.

As indicated earlier, chemical weed control results in less detrimental effects to the soil structure, as well as the tree surface root system than does cultivation. However, few preemergence herbicides are registered for use in young fruit, because of their greater sensitivity.

The purpose of this study was to evaluate the effect of selected preemergence herbicides on weed control and the shoot growth of non-bearing apples and peaches. The effect of these chemicals on tree growth is complicated by several factors: the possibility of inadequate weed control with the reduced rates used; weed shifts from the use of selective herbicides; visible and non-visible injury to the young trees from the use of chemicals; environmental factors including: satisfactory rainfall at the time of herbicide application to insure herbicide activity; and the topography, as it influenced available moisture, sunlight, and weed spectrum present.

LITERATURE REVIEW

Site preparation for the establishment of an orchard should be initiated at least one and preferably two years in advance of planting the trees. Perennial weeds are the most critical problem in the orchard, and can be dealt with most successfully if weed control is started early. Their growth represents the natural succession pattern that would eventually convert the orchard to a forest.

The first step in orchard establishment is to clear the land. Following this, if the vegetation is allowed to grow again, weed control can be applied for perennial species. Rom and Frear (73) found the best time to apply herbicides for perennial weed control was the summer prior to planting, when greater numbers of weed species are in active growth. Perennial weeds were eliminated in the pasture area with the application of either glyphosate (N-(phosphono-methyl)glycine) alone or in combination with diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea) or oryzalin (3,5-dinitro-N^4,N^4-dipropylsulfanilamide). Cultivation to a depth of 20 inches, is often used in conjunction with chemicals for effective perennial weed control. Fall plowing is preferable to permit the sod to decompose over the winter (26). As a possible alternative to glyphosate, the effectiveness of a bare fallow can be increased with the herbicide amitrol (3-amino-*s*-triazole) which provides control of both red sorrel (*Rumex acetosella* L.) and Canada thistle (*Cirsium arvense* (L.) Scop.) (71). A cover crop is seeded following cultivation to improve the soil structure. A grass cover crop such as a winter rye or a sorghum cultivar will allow the use of a herbicide with broadleaf activity such as 2,4-D (2,4-dichlorophenoxy)acetic acid), MCPA ((4-chloro-*o*-tolyl)oxy)acetic acid), or dicamba (3,6-dichloro-*o*-anisic acid). Two fall planted cover crops with allelopathic properties, 'Balboa' rye or 'Tecumseh' wheat (*Triticium aestivum* L.) may also aid in weed suppression (67).

When the trees are planted in March, both a contact herbicide, to kill existing vegetation, and a preemergence herbicide for residual control, are applied. Any resistant weeds are controlled with spot applications of paraquat, 2,4-D, or a wick application of glyphosate.

The soil management system resulting in the greatest tree growth depends on the climate, apple cultivar, and topography of the land. In drier areas, with shallow soils, maximum growth has occurred with a mulch. The yield of 'Golden Delicious' apples and 'Hooker' peaches was doubled in the first two years of bearing with a hay mulch (18).

Fruit size, a critical factor in determining profit, was larger for both apples and peaches. Greater vegetation growth for peaches and heavier blossoming for apples accounted for the yield increases. The larger yields of the first two seasons resulted in a net profit equal to the cost of materials used in the four year period. In a trial with young peaches, either a mulch or strip herbicide treatment produced larger crops and trunk circumference measurements than those under grass (52). Mulches are advantageous in dry areas for several reasons. Evaporation from the orchard floor is reduced to one-third that of the cultivated soil; weed competition is discouraged; the soil is insulated from extremes in temperature; and the favorable environment thus created encourages root growth in the fertile surface layers (90). Mulching can be detrimental if sufficient rainfall is received to cause a waterlogged condition. Lower soil temperatures during the growing season, increased soil carbon-dioxide levels and decreased soil aeration have all been noted as possible reasons for diminished yields under a straw mulch (72). If a mulch is applied in a strip with a hilled-up tree row, these disadvantages should be minimal. Other possible disadvantages of a mulch include slightly higher frost injury to blossoms, cost and lack of availability of mulching materials, and rodent damage (85).

However, mulch applied in the late fall is normally wet and unattractive to the mice the following spring and summer.

Mulch materials vary in their plant nutrient content. Hay is the best with respect to nutrient value. Straw is slightly higher than sawdust or wood shavings. Thus, a greater amount of N is incorporated with the wood sawdust or shavings to satisfy the needs of the microorganisms decomposing these materials. The release of N is unpredictable with a manure mulch and its use has been associated with bitter pit of apples and excessive, succulent growth. Waste tire material and seaweed have also been utilized as a mulching material (85). Foliage color was best for trees with a hay or seaweed mulch. Correspondingly, the greatest accumulation of N, P, Mg, and K occurred under a hay mulch. This accumulation was not found with a sawdust or sod mulch.

Like a mulch, a completely weed-free herbicide-treated orchard floor is beneficial on light soils with poor water reserves (10). Water is conserved more efficiently with this system than with either sod or strip herbicide treatments (10). As a result of the greater water conservation, increases in yield ranging from 29% to 41% have been reported for orchards converted from the strip herbicide to overall bare system (10,83). Trees were also able to produce heavier crops year after year. The most critical disadvantage of this system is the possibility of substantial erosion. When growers using this system were surveyed, 37% reported erosion problems, with 11% of these experiencing significant erosion. Forty-two percent of the growers changed from the overall herbicide system to a strip system because of erosion. If the land is level, water runoff and soil erosion can be reduced with either a moss or mulch cover (72,83). An application of mulch each winter to herbicide plots has the additional benefit of maintaining organic matter resulting in better aeration and moisture infiltration (26). Another difficulty encountered with the overall herbicide system is the accumulation of the chemical in some areas of the orchard with depletion in other areas leading to poor weed control (11). Neither of these problems is present with the herbicide strip system.

The herbicide-treated, weed-free strip system is widely used. The growth and yield responses are generally intermediate in comparison to the overall herbicide system and sod covered or cultivated system (19,83). Lord and Vlach (52) found the growth of peach trees under a herbicide strip system similiar to hay mulch and cultivation, but significantly greater than in the grass-covered areas. They cite several advantages of this system: a reduction in fruit bruising at harvest; ease of weed control close to the trunk; better spray coverage for the peach tree borer; and the lack of disturbance of the surface roots. The use of the herbicide strip system often significantly increases yield in comparison to a sod-covered orchard. Baxter and Newman (19) found the yields of 'Jonathon' and 'Golden Delicious' apples were increased by 37% and 60% respectively. They felt this was the result of the reduced competition for nitrogen from the grass covercrop. Sufficient moisture, also a key factor in determining yield, may be further conserved in dry seasons by either desiccating the grass alleyways or utilizing a colored vinyl film, possibly impregnated with a herbicide (50,101). Trzcinsky and Warzee (89) reported a black plastic mulch resulted in both improved fruit quality and growth in a drought year.

Studies in Canada indicate herbicide use has another benefit in peach culture. Newly planted peach trees exhibited greater freezing resistance of the bark and wood tissue in the dormant scions (55). The trees on the weeded plots exhibited a more satisfactory carbohydrate level, which promoted acclimatization.

Limited numbers of herbicides are registered for use in young fruit, because of the greater sensitivity of newly-planted trees. Depth of planting, the particular rootstock, and the time of application influence the tolerance of young trees (80). In general, herbicides cannot be applied at the rates recommended for a mature orchard. At lower rates, a number of preemergence herbicides have been successfully used in various experiments. These include simazine, napropamide (2-(α-naphthoxy)-N,N-diethylpropionamide), diuron, oxfluorfen, (2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-trifluoromethyl)benzene, norflurazon (4-chloro-5(methylamino)-2-(α,α,α-trifluoro-m-tolyl)-3(2H)-pyridazone and oryzalin (3,4,87). The trees must be at least one-year-old in the field before simazine or diuron can be used. Simazine was used at rates varying from 1.5 to 2.2 kg/ha. A mixture of oryzalin (9 kg/ha) and simazine (2.2 kg/ha) suppressed 94% of the weeds (104). However the young peach trees achieved their best growth with a lower rate of this mixture (2.2 kg/ha) of oryzalin and simazine. Another simazine mixture found to give effective weed control for peach plantings is simazine and napropamide (1). Simazine, applied singly, provided greater broadleaf control than when applied in combination with napropamide, but only the mixture controlled grasses. Diuron applied at rates from 2-5 kg/ha, provided satisfactory annual weed control (82). When diuron was applied in both April and June at a

3.2 kg/ha rate, it suppressed emergence of large crabgrass for the entire season (23). One application of diuron suppressed small-flowered galinsoga (Galinsoga parviflora Cav.), redroot pigweed (Amaranthus retroflexus L.), common lambsquarters (Chenopodium album L.), shepherdspurse (Capsella bursa-pastoris (L.) Medic), and barnyardgrass (Echinochloa crus-galli (L.) Beauv.). The perennials, field bindweed (Convolvulus arvensis L.), bermudagrass (Cynodon dactylon (L.) Pers.) and brambles (Rubus allegheniensis Porter) were resistant to both diuron and simazine (91). Oxyfluorfen, provided good broadleaf control, but poor control of emerged grasses and crucifers (79). The addition of paraquat, or the use of a mixture containing oxyfluorfen and either oryzalin or napropamide provided excellent broad spectrum control. Oxyfluorfen was applied at rates varying from 2.5 to 10 kg/ha in the studies. The herbicide oryzalin was applied at rates varying from 2.2 to 3.4 kg/ha, with the higher rate reported to give full season weed control of several annual grass and broadleaf weeds. Napropamide was safe in two year old peach plantings at rates up to 8 kg/ha (73). Norflurazon was also applied after the trees were established for one year. Russo and Ummel (76) reported norflurazon controlled a wide range of weeds including the annual grasses, annual bluegrass, barnyardgrass, large crabgrass, witchgrass, (*Panicum capillare* L.) and two annual broadleaf weeds, chickweed (*Stellaria media* (L.) Cyrill), and shepherdspurse. The application rate varied from 3 to 5.5 kg/ha depending on the soil type.

Few of the preemergence herbicides provided control of perennial weeds and none of them effectively controlled brambles. The systemic herbicide glyphosate is effective for this purpose if used with great caution. Less injury occurred when it was applied in May or June; application after August 1 increases the probability of injury (98). There is a variation in sensitivity among the different apple cultivars to glyphosate (81). A wick application of glyphosate achieved safe, effective control of the perennial weed, johnsongrass (*Sorghum halepense* (L.) Pers.) (29).

MATERIALS AND METHODS

Five experiments were conducted during the spring and summer of 1982 to evaluate 11 herbicides, applied singly and in combination for weed control and crop response of young apple and peach trees. Experimental data included weed control ratings, plant growth and injury responses. The experimental plantings were located on two sites, Doe Creek farm in Hoges Chapel, Virginia (Giles county) and Layman Brothers' orchard in Daleville, Virginia (Botetourt County). The sites were tilled prior to transplanting the apple and peach seedlings. A knapsack sprayer was used to apply herbicides in 449-486 l/ha of water. Paraquat was included in all sprays to kill existing weeds (561 g/ha plus the surfactant Ortho X-77 (16 oz/100 gal).[1] A randomized complete-block design was used to minimize variability due to soil differences resulting from the rolling topography.

The Hoges Chapel site had a loam soil with 2.2% organic matter and a pH of 7.0. The 'Red Delicious' apple trees were transplanted April 3, 1981 and treated April 14, 1981 and April 12, 1982, respectively. All trees were spaced 7 m apart in rows that were 8.5 m apart. All treatments were

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[1] Nonionic surfactant containing alkylpolyoxyethylene glycols, free fatty acids, and isopropanol. Chevron Chem. Co., 575 Market St., San Francisco CA. 94105

replicated three times with 32 single-tree plots per block. Each experimental plot contained one tree and measured 1.5 m in width and 6.7 m in length.

There were several changes in herbicide treatments in 1982: plots previously treated with dichlobenil in 1981 were treated with metolachlor (2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide; trifluralin (α,α,α-trifluoro-2,6-dinitro-N,N- dipropyl-p-toluidine) plots were changed to combinations of either oxyfluorfen and simazine or diuron; EPTC (S-ethyl dipropylthiocarbamate) plots were treated with combinations of norflurazon and either simazine or diuron; plots treated with simazine, diuron or untreated checks were previously untreated; all other treatments remained the same. This report is concerned with the data from 1982 alone.

Rain (5 cm) fell within two weeks after applying the herbicides. Weed species present at the time of treatment were below 20 cm in height and included the perennials dandelion (Taraxacum officinale Weber) and white clover, the winter annuals shepherdspurse, red deadnettle (Lamium purpureum L.) and henbit (Lamium amplexicaule L.), and the annuals pineapple weed (Matricaria matricarioides (Less.) Porter), common mallow (Malva neglecta Wallr.), and prickly lettuce (Lactuca serriola L.).

Weed control ratings were made on May 20,1982 and estimates of the ground covered with weeds were recorded June 8,1982. Weed control ratings were on a scale of 1 to 10, with 10 indicating complete control. Both weed control and ground cover ratings are expressed as percentages in the tables. Scion circumference was measured 5 cm above the graft union where a latex marker had been painted. Measurements were recorded at the beginning of the growing season on April 10,1982 and at the end of the season, November 2,1982. The number and length of new shoots, as well as any injury symptoms were also recorded at this later date.

The second experiment was located at the Layman Brothers orchard. The loam soil contained 3.6% organic matter with a pH of 6.4. Newly transplanted 'Smoothie' (Golden Delicious) apple trees (transplanted in March of 1982) were used in single-tree plots measuring 1.8 m by 4.9 m and spaced 4.9 m apart. The residual herbicides were applied on April 15,1982. All treatments were replicated five times. The weed species present at the time of treatment included broadleaf weed species, annual bluegrass, and orchardgrass, all ranging from 1.3 cm-10 cm in height. On June 9,1982 estimates of the ground covered by broadleaf and grass weeds were recorded. On June 25, 1982 weed control ratings were taken and injury symptoms noted. Measurements of the scion circumference were taken on April 29, 1982 and November 30, 1982. Total new shoot growth was measured on this later date.

The third, fourth, and fifth experiments, each employing single-tree plots were also located at Layman Brothers' orchards. The soil on the third experimental site was a loam with 2.4% organic matter and a pH of 5.4. 'Red Chief' (Red Delicious) apple trees were one year old when the residual herbicides were applied on April 22, 1982. Ninety-five percent of the ground was covered with annual rye at the time of treatment. There were also scattered broadleaf weeds including broadleaf dock (Rumex obtusifolius L.) up to 20 cm in height, dandelion and scattered white clover. Individual plots were 1.8 by 4.9 m long and spaced 4.9 m apart in the tree rows. All treatments were replicated six times. Rainfall (3.6 cm) occurred four days after herbicide application. Scion growth measurements, taken 5 cm above the graft line were made on April 29, 1982 and November 30, 1982. Total new shoot growth measurements were also made on November 30, 1982. Estimates of percent ground covered with weeds and weed control ratings were taken on June 9, 1982 and on June 25, 1982, respectively. Injury symptoms were recorded throughout the season.

The soil at the fourth experimental site had a pH of 6.6 and 1.7% organic matter. Peach trees (several varieties) established for one year in the field, were space 4.9 m apart in individual plots measuring 1.8 by 4.9 m. The residual herbicides were applied on April 29 and April 30, 1982. All treatments were replicated five times. Rainfall was not recorded until May 18 (3 cm).

Weed species present at the time of treatment were annual rye, dandelion, red clover, white clover, yellow rocket (Barbarea vulgaris R. Br.), broadleaf dock, prickly lettuce, and common lambsquarters. These were mowed to a 7.6-10 cm height prior to treatment. Scion circumference and approximate tree height were measured on April 29, 1982. End of the season scion circumference measurements were made on November 30, 1982. Estimates of the ground covered by weeds and general impressions of the plots were recorded on July 9, 1982 and July 29, 1982, respectively.

The soil for the fifth experiment was a loam with 2.4% organic matter and a pH of 5.4. One-year-old 'Red Chief' (Red Delicious) apple trees were spaced 4.9 m apart on plots measuring 8.8 m^2. The rye and other weed species present were mowed to a 7.6-10 cm height prior to treatment. Residual herbicides were applied May 5, 1982. The treatments were replicated six times. Rainfall (3.0 cm) was recorded within two weeks of treatment. Weed species present at the time of treatment were annual rye, dandelion, broadleaf dock and red clover. Weed control ratings were taken on June 9, June 25, and July 29, 1982 at which time any injury symptoms were noted. The scion circumference measurements were made on May 13, 1982 and again on November 30, 1982. New shoot growth measurements were recorded at the later date.

RESULTS AND DISCUSSION

Experiment 1

There were several treatments that provided satisfactory early and late season weed control (Table 1). These included: metolachlor (2.3 kg/ha); norflurazon (6.8 kg/ha); norflurazon and simazine (4.6 + 1.2 kg/ha) and norflurazon and diuron (4.6 + 1.2 kg/ha). The percent groundcover present on July 8, 1982 ranged from 10% for norflurazon to 33% for metolachlor. The herbicide combinations, with the exception of the oxyfluorfen combinations, provided satisfactory early season weed control. Simazine and diuron applied singly, both at a 3.6 kg/ha rate, also gave good early season weed control. However, by the third month following treatment, there was a vigorous groundcover of broadleaf weeds present in the plots, many of which were perennials. Virginia pepperweed (*Lepidium virginicum* L.), yellow nutsedge (*Cyperus esculentus* L.), broadleaf dock, curly dock (*Rumex crispus* L.), prickly lettuce, and annual fleabane (*Erigeron annuus* (L.) Pers.) were the most plentiful species. Common mallow, red sorrel, common yellow woodsorrel (*Oxalis stricta* L.), dandelion, brambles, speedwell (*Veronica officinalis* L.), red deadnettle, perennial sowthistle (*Sonchus arvensis* L.), wild garlic

Table 1. Effect of herbicides on weed control and percent groundcover in one-year-old 'Red Delicious' apples. Hoges Chapel, Virginia. Transplanted April 3, 1981. Treated April 12, 1982 with preemergence (residual) herbicides.[a] Data are averages of 3 replications.[b]

Treatment	Rate	Weed control June 20, 1982	Groundcover July 8, 1982
	(lb ai/A)	(%)	(%)
1. Metolachlor (Dual 8E)	2.0	85a	33a
2. Metolachlor (Dual 8E)	3.0	66a	53b
3. Napropamide (Devrinol 50W)	4.0	53c	88c
4. Diphenamid (Enide 50W)	4.0	41c	95c
5. Diphenamid (Enide 50W)	6.0	61a	89c
6. Oxyfluorfen (Goal 2E)	1.0	65a	80c
7. Oxyfluorfen (Goal 2E)	2.0	59a	74c
8. Norflurazon (Solicam 80W)	2.0	65a	81c
9. Norflurazon (Solicam 80W)	4.0	67a	72c
10. Norflurazon (Solicam 80W)	6.0	95a	10a
11. Oryzalin (Surflan 4AS)	2.0	38c	85c
12. Oryzalin (Surflan 4AS)	4.0	25c	98c
13. Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	1.0 + 1.0	66a	57b
14. Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	2.0 + 1.0	72a	72c
15. Oxyfluorfen (Goal 2E) + diuron (Karmex 80W)	2.0 + 1.0	77a	79c
16. Paraquat (Ortho Paraquat) only	0.5	30c	92c
17. Paraquat (Ortho Paraquat) only	1.0	55b	78c
18. Pendimethalin (Prowl 4E)	0.75	37c	89c
19. Pendimethalin (Prowl 4E)	1.5	48c	80c
20. Norflurazon (Solicam 80W) + simazine (Princep 4L)	2.0 + 1.0	79a	47b
21. Norflurazon (Solicam 80W) + simazine (Princep 4L)	4.0 + 1.0	83a	23a
22. Norflurazon (Solicam 80W) + diuron (Karmex 80W)	4.0 + 1.0	90a	20a
23. Napropamide (Devrinol 50W) + simazine (Princep 4L)	4.0 + 1.0	79a	57b
24. Napropamide (Devrinol 50W) + diuron (Karmex 80W)	4.0 + 1.0	80a	63c
25. Oryzalin (Surflan 4AS) + simazine (Princep 4L)	2.0 + 1.0	79a	63c
26. Oryzalin (Surflan 4AS) + simazine (Princep 4L)	4.0 + 1.0	72a	86c
27. Oryzalin (Surflan 4AS) + diuron (Karmex 80W)	4.0 + 1.0	80a	73c
28. Simazine (Princep 4L)	3.0	91a	61c
29. Diuron (Karmex 80W)	3.0	93a	47b
30. Untreated	-	20c	88c

[a]All sprays also contained the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant to burn back existing vegetation.

[b]Means within a column by the same letter are not significantly different at the 5% level according to the Scott Knott test.

(<u>Allium vineale</u> L.), common pokeweed (<u>Phytolacca americana</u> L.), and hedge mustard (<u>Sisymbrium offininale</u> (L.) Scop.) were also present. There were very few annual grasses, however. As evident from Table 1, with the exception of the higher rate of norflurazon, simazine, and diuron, the single treatments did not satisfactorily suppress weed growth either early or late in the season.

The lack of full season weed control for the majority of the chemicals appeared to be due to heavy weed pressure from a wide spectrum of broadleaf weeds, many of which were perennials. The herbicides used would not be expected to control these weeds. The following weeds were present in the check plots in Experiment 1: common burdock (<u>Arctium minus</u> (Hill) Bernh.), brambles, dandelion, red deadnettle, prickly lettuce, common yellow woodsorrel, pineappple weed, lambsquarters, hedge mustard, shepherdspurse, orchardgrass, Virginia pepperweed, red and white clovers, annual fleabane, speedwell, catchweed bedstraw (<u>Galium aparine</u> L.), horseweed (<u>Conyza canadensis</u> (L.) Cronq.), common hawkweed (<u>Hieracium vulgatum</u> Fries), and broadleaf plaintain (<u>Plantago major</u> L.). A comparison with the untreated checks suggests another factor: it appears that the use of herbicides released one of the most vigorous weeds in this orchard, Virginia pepperweed. This weed was not present to any extent in the checks, but grew rampantly in the treated plots. Rainfall is a third factor that may have played a part in the lack of herbicide effectiveness. Rainfall adequate to activate the chemicals did not fall until two weeks after the treatments were applied. This is the maximum amount of time allowable; beyond this it would be necessary to use overhead irrigation or mechanically incorporate the herbicides into the top 5 cm of the soil to assure contact with the germinating weed seedlings. It is hard to determine to what extent, if any, rainfall played a part, because there were few annual grass weeds present in the orchard, even in the untreated checks.

Based on the Scott Knott cluster analysis test, there were significant differences in the 1981 season new shoot growth. In the 1981 season, trifluralin and EPTC were noticeably weaker than the other treatments. Both of these compounds are volatile with a short residual life. Trees in these weedy plots had a significantly smaller amount of new shoot growth. There were no significant differences in the 1982 season scion circumference or new shoot growth (Table 2). There was a trend, however, that the trees growing on plots exhibiting satisfactory weed control also had greater growth.

Table 2. Effect of herbicides on total length of new shoot growth for the 1981 and 1982 growing seasons and new scion circumference growth for the 1982 growing season in 'Red Delicious' apples. Hoges Chapel, Virginia. Transplanted April 3, 1981. Treated April 12, 1982 with preemergence (residual) herbicides.[a] Data are averages of three replications.[b]

Treatment	Rate	New shoot growth 1981 season	New shoot growth 1982 season	Scion circumference growth[c] 1982 season
	(lb ai/A)	(cm)	(cm)	(cm)
1. Metolachlor (Dual 8E)	2.0	131b	622 ns	1.8 ns
2. Metolachlor (Dual 8E)	3.0	217b	527	1.5
3. Napropamide (Devrinol 50W)	4.0	297a	499	1.6
4. Diphenamid (Enide 50W)	4.0	258a	482	1.2
5. Diphenamid (Enide 50W)	6.0	298a	700	1.4
6. Oxyfluorfen (Goal 2E)	1.0	267a	730	1.6
7. Oxyfluorfen (Goal 2E)	2.0	409a	603	1.6
8. Norflurazon (Solicam 80W)	2.0	300a	472	1.2
9. Norflurazon (Solicam 80W)	4.0	218b	470	1.2
10. Norflurazon (Solicam 80W)	6.0	203b	550	1.2
11. Oryzalin (Surflan 4AS)	2.0	224b	339	1.0
12. Oryzalin (Surflan 4AS)	4.0	158b	295	1.1
13. Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	1.0 + 1.0	158b	420	1.2
14. Oxyfluorfen (Goal 2E) + simazine (Princep 4LO	2.0 + 1.0	212b	591	1.4
15. Oxyfluorfen (Goal 2E) + diuron (Karmex 80W)	2.0 + 1.0	274a	455	0.9
16. Paraquat (Ortho Paraquat) only	0.5	262a	421	1.3
17. Paraquat (Ortho Paraquat) only	1.0	232b	603	1.4
18. Pendimethalin (Prowl 4E)	0.75	259a	399	1.0
19. Pendimethalin (Prowl 4E)	1.5	209b	285	1.1
20. Norflurazon (Solicam 80W) + simazine (Princep 4L)	2.0 + 1.0	214b	467	1.4
21. Norflurazon (Solicam 80W) + simazine (Princep 4L)	4.0 + 1.0	180b	559	1.5
22. Norflurazon (Solicam 80W) + diuron (Karmex 80W)	4.0 + 1.0	204b	674	1.3
23. Napropamide (Devrinol 50W) + simazine (Princep 4L)	4.0 + 1.0	177b	714	2.0
24. Napropamide (Devrinol 50W) + diuron (Karmex 80W)	4.0 + 1.0	158b	530	1.9
25. Oryzalin (Surflan 4AS) + simazine (Princep 4L)	2.0 + 1.0	280a	828	2.2
26. Oryzalin (Surflan 4AS) + simazine (Princep 4L)	4.0 + 1.0	244a	663	1.8
27. Oryzalin (Surflan 4AS) + diuron (Karmex 80W)	4.0 + 1.0	138b	553	1.5
28. Simazine (Princep 4L)	3.0	193b	735	1.9
29. Diuron (Karmex 80W)	3.0	288a	587	1.8
30. Untreated	-	227b	436	1.1

[a]All sprays also contained the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant to burn back existing vegetation.

[b]Means within a column followed by the same letter are not significantly different at the 5% level according to the Scott Knott test; ns denotes no significant differences among all treatments.

[c]Current season's scion circumference growth measured 5 cm above the scion/stock graft line, marked by latex paint.

A number of factors probably contributed to the unexpected lack of significant differences in tree growth. The majority of the herbicides provided unsatisfactory weed control, particularly by the third month. Accordingly, on July 30, 1982, the commercial grower felt it necessary to relieve the weed pressure by hoeing, mowing, and spraying paraquat in an area measuring 1.5 m^2 around all the trees, thereby equalizing the treatments for the remainder of the season. Thus, full weed competition was never allowed to develop. Both of these factors, the lack of satisfactory control of the broad spectrum of weeds present and the growers actions to relieve the weed pressure prematurely could influence the results.

The results do not indicate that the herbicides injured the young trees: the untreated controls had the lowest amount of scion circumference and new shoot growth in most instances. There were no external symptoms of herbicide injury.

Erosion is one of the potential problems with preemergence herbicide use on sloping terrain. Our tests indicated that the use of a combination of cultivation and residual herbicides may result in substantial erosion. When the Hoges Chapel orchard was examined on July 29, 1983, a year following treatment, significant erosion was apparent.

The soil at this site received residual herbicide treatments, as well as cultivation, for two seasons. There are several orchard soil management programs that could potentially avoid this problem. Two logical approaches are the use of very narrow treated strips with a tall fescue (Festuca arundinacea Schreb.) or creeping red fescue (Festuca rubra L.) groundcover; or alternatively, the use of a groundcover desiccated with a contact herbicide. As noted earlier, several groundcovers such as annual rye, have displayed allelopathic properties when managed in this way. Researchers working with peach seedlings grown in a dead sod report excellent growth when compared to conventional methods of establishment.

Experiment 2

The most effective treatments in the newly transplanted 'Smoothie' (Golden Delicious) apple trees were oxyfluorfen (2.3 kg/ha) and oxyfluorfen combinations with either napropamide or oryzalin (2.3 + 4.6 kg/ha) (Table 3). There were more annual grasses present when oxyfluorfen was applied at the lower rate (1.2 kg/ha). Oxyfluorfen controlled annual broadleaf weeds better than perennial grasses, in this instance, quackgrass (Agropyron repens (L.) Beauv). Yellow nutsedge escaped control. The results were

Table 3. Effect of herbicides on percent groundcover and weed control in newly transplanted 'Smoothie' (Golden Delicious) apples. Daleville, Virginia. Treated April 15, 1982 with preemergence (residual) herbicides.[a] Data are averages of five replications.[b]

	Treatment	Rate	Groundcover June 9, 1982	Weed control June 25, 1982 Anb[c]	Angr	Prbl	Prgr
		(lb ai/A)	(%)	(%)			
1.	Napropamide (Devrinol 50WP)	4.0	72c	22c	78a	44b	72a
2.	Oryzalin (Surflan 4AS)	2.0	92c	6c	74a	36b	58a
3.	Oryzalin (Surflan 4AS)	4.0	76c	22c	78a	52b	54a
4.	Diphenamid (Enide 50W)	4.0	76c	32c	68a	34b	62a
5.	Diphenamid (Enide 50 W)	6.0	69c	26c	70a	42b	76a
6.	Oxyfluorfen (Goal 2E)	0.5	36b	54b	30b	40b	62a
7.	Oxyfluorfen (Goal 2E)	1.0	21b	71b	71a	63a	70a
8.	Oxyfluorfen (Goal 2E)	2.0	26b	87a	87a	77a	61a
9.	Oxyfluorfen (Goal 2E) + napropamide (Devrinol 50 WP)	2.0 + 4.0	5a	90a	90a	85a	68a
10.	Oxyfluorfen (Goal 2E) + oryzalin (Surflan 4AS)	2.0 + 4.0	14a	83a	74a	73a	56a
11.	Norflurazon (Solicam 80W)	2.0	82c	28c	72a	38b	22b
12.	Norflurazon (Solicam 80W)	4.0	75c	30c	66a	52b	36b
13.	Norflurazon (Solicam 80W)	6.0	87c	22c	68a	38b	44b
14.	Pendimethalin (Prowl 4E)	0.75	90c	14c	64a	52b	62a
15.	Pendimethalin (Prowl 4E)	1.5	92c	12c	48b	38b	62a
16.	Metolachlor (Dual 8E)	2.0	77c	30c	60a	56b	72a
17.	Metolachlor (Dual 8E)	3.0	76c	12c	74a	56b	72a
18.	Alachlor (Lasso 4E)	2.0	89c	12c	68a	40b	68a
19.	Alachlor (Lasso 4E)	3.0	85c	16c	76a	56b	78a
20.	Paraquat (Ortho Paraquat) only	0.5	92c	32c	22b	40b	72a
21.	Untreated	-	97c	8c	38b	46b	67a

[a]Plots were also treated with the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant on April 16, 1982 to burn back existing vegetation.

[b]Means within a column followed by the same letter are not significantly different at the 5% level according to the Scott Knott test.

[c]Anbl = Annual broadleaf; Angr = Annual grass; Prbl = Perennial broadleaf; and Prgr = Perennial grass.

similiar with the oxyfluorfen combinations: perennial grass and yellow nutsedge control were weak. All of these treatments remained effective after 3.5 months. The metolachlor (2.3 and 3.6 kg/ ha), alachlor (2.3 kg/ ha), and norflurazon (2.3 kg/ ha) treatments provided good annual grass control and some ragweed suppression into the end of July, but unsatisfactory control of the wide spectrum of broadleaf weeds present. The majority of the plots were well overgrown after 3.5 months. Two contributing factors were the widespread spectrum of broadleaf weeds, as well as perennial grasses present, and the lack of rainfall following treatment application. The broadleaf weeds included common ragweed , lambsquarters, Pennsylvania smartweed (Polygonum pensylvanicum L.) , broadleaf plaintain, redroot pigweed , Virginia creeper (Parthenocissus quinquefolia (L.) Planch., annual fleabane, hedge mustard, red deadnettle, common milkweed (Asclepias syriaca L.), common yellow wood sorrel, tall morningglory (Ipomoea purpurea (L.) Roth) and poison ivy (Rhus radicans L.).

All of the preemergence herbicides need to be moved into the soil a distance of 2.5-5 cm by either rainfall, overhead irrigation, or mechanical incorporation in order to exert their activity. The recommendation for napropamide and diphenamid calls for incorporation or irrigation within 24 hr if no rainfall has occurred. Similiarly, a seven day lapse period without rainfall is allowed for oryzalin, pendimethalin, and metolachlor before supplementary water is necessary. Thus, the lack of rain the first week following the application of these chemicals may have decreased their effectiveness. Substantial rainfall, amounting to 3.8 cm was received by the end of two weeks.

The new shoot growth and scion circumference for the 1982 season were significantly greater for the three most effective treatments (Table 4). To further define the relationship between weed competition and tree growth, it would be necessary to conduct the experiment under more controlled conditions. Weed control ratings are not adequate measures of weed competition for detailed studies of the effect of weed competition on growth, because of the variability in the competiveness of different weed species. The particular environment also plays a role in determining which weed species are favored. Further studies to determine whether the relationship between weed competition and tree growth is linear or curvilinear, would require more controlled conditions. Treatments consisting of solid stands of a particular weed species, as well as completely weed-free plots would be included. The weeds or groundcover could be clipped to obtain a measurement of the weed

Table 4. Effect of herbicides on the total length of new shoot growth and scion circumference growth for the 1982 growing season in newly transplanted 'Smoothie' (Golden Delicious) apples, Daleville, Virginia. Treated April 15, 1982 with preemergence (residual) herbicides.[a] Data are averages of five replications.[b]

Treatment	Rate	New shoot growth 1982 season	New scion circumference growth[c] 1982 season
	(lb ai/A)	(cm)	(cm)
1. Napropamide (Devrinol 50WP)	4.0	126b	0.4c
2. Oryzalin (Surflan 4AS)	2.0	207b	0.7c
3. Oryzalin (Surflan 4AS)	4.0	134b	0.7c
4. Diphenamid (Enide 50W)	4.0	175b	0.7c
5. Diphenamid (Enide 50W)	6.0	133b	0.5c
6. Oxyfluorfen (Goal 2E)	0.5	220b	1.2b
7. Oxyfluorfen (Goal 2E)	1.0	177b	1.0b
8. Oxyfluorfen (Goal 2E)	2.0	310a	1.7a
9. Oxyfluorfen (Goal 2E) + napropamide (Devrinol 50 WP)	2.0 + 4.0	276a	1.5a
10. Oxyfluorfen (Goal 2E) + oryzalin (Surflan 4AS)	2.0 + 4.0	339a	1.4a
11. Norflurazon (Solicam 80W)	2.0	201b	1.0b
12. Norflurazon (Solicam 80W)	4.0	180b	1.0b
13. Norflurazon (Solicam 80W)	6.0	207b	1.1b
14. Pendimethalin (Prowl 4E)	0.75	145b	0.5c
15. Pendimethalin (Prowl 4E)	1.5	191b	0.8c
16. Metolachlor (Dual 8E)	2.0	157b	1.2b
17. Metolachlor (Dual 8E)	3.0	168b	1.0b
18. Alachlor (Lasso 4E)	2.0	127b	0.7c
19. Alachlor (Lasso 4E)	3.0	207b	1.0b
20. Paraquat (Ortho Paraquat) only	0.5	112b	0.5c
21. Untreated	-	134b	0.5c

[a]Plots were also treated with the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant on April 16, 1982 to burn back existing vegetation.

[b]Means within a column followed by the same letter are not significantly different at the 5% level according to the Scott Knott test.

[c]Current season's scion circumference growth measured 5 cm above the scion/stock graft line.

competition. Notes regarding the time of a particular weed species' emergence are also useful in determining when competition is detrimental.

The substantial erosion that was seen in Experiment 1, located in Daleville, Virginia., was not evident at the Layman Brothers' orchard, the site of Experiments 2, 3, 4, and 5. The residual treatments were applied at this site for one year only and the amount of cultivation was also less. There was also an outbreak of johnsongrass in many of the plots, which was killed back with a wick application of glyphosate, leaving much dead debris. It is possible the root system of these plants played a role in reducing erosion in these experiments.

Experiment 3

As indicated in Table 5, the majority of the treatments controlled annual weeds, but released a variety of perennials. The most abundant perennials were johnsongrass, horsenettle (*Solanum carolinense* L.) poison ivy, common milkweed, Virginia creeper, field bindweed (*Convolvulus arvensis* L.), tall morningglory, broadleaf dock, curly dock, dandelion, and buckhorn plaintain (*Plantage lanceolata* L.). It was evident that the treatments were more overgrown than the checks, which had a rye groundcover. Thus, although a

Table 5. Effect of herbicides on percent groundcover and weed control in 'Red Chief' (Red Delicious) apples. Daleville, Virginia. Treated April 22, 1982 with preemergence (residual) herbicides.[a] Date are averages of six replicates.[b]

	Treatment	Rate	Groundcover June 9, 1982	Weed control June 25, 1982 Anbl[c]	Angr	Prbl	Prgr
		(lb ai/A)	(%)	(%)			
1.	Metolachlor (Dual 8E)	2.0	42a	87a	62c	48a	40 ns
2.	Metolachlor (Dual 8E)	3.0	50a	90a	75b	37b	32
3.	Napropamide (Devrinol 50W)	4.0	55b	95a	83a	30b	20
4.	Napropamide (Devrinol 50 WP) + simazine (Princep 4L)	4.0 + 1.0	57b	97a	93a	38a	30
5.	Napropamide (Devrinol 50 WP) + diuron (Karmex 80W)	4.0 + 1.0	60b	97a	97a	50a	12
6.	Diphenamid (Enide 50W)	4.0	48a	92a	67c	23b	30
7.	Diphenamid (Enide 50W)	6.0	61b	100a	85a	43a	17
8.	Oxyfluorfen (Goal 2E)	1.0	40a	93a	76b	62a	58
9.	Oxyfluorfen (Goal 2E)	2.0	36a	97a	92a	59a	38
10.	Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	1.0 + 1.0	35a	100a	92a	53a	33
11.	Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	2.0 + 1.0	47a	97a	93a	53a	23
12.	Oxyfluorfen (Goal 2E) + diuron (Karmex 80W)	2.0 + 1.0	32a	98a	88a	65a	35
13.	Norflurazon (Solicam 80W)	2.0	50a	98a	93a	53a	28
14.	Norflurazon (Solicam 80W)	4.0	44a	94a	100a	23b	15
15.	Norflurazon (Solicam 80W)	6.0	39a	93a	98a	55a	42
16.	Norflurazon (Solicam 80W) + simazine (Princep 4L)	2.0 + 1.0	43a	100a	98a	47a	35
17.	Norflurazon (Solicam 80W) + simazine (Princep 4L)	4.0 + 1.0	44a	97a	100a	43a	32
18.	Norflurazon (Solicam 80W) + diuron (Karmex 80W)	4.0 + 1.0	41a	97a	97a	52a	53
19.	Oryzalin (Surflan 4AS)	2.0	46a	97a	92a	45a	28
20.	Oryzalin (Surflan 4AS)	4.0	48a	93a	97a	33b	45
21.	Oryzalin (Surflan 4AS) + simazine (Princep 4L)	2.0 + 1.0	57b	93a	95a	38b	12
22.	Oryzalin (Surflan 4AS) + simazine (Princep 4L)	4.0 + 1.0	40a	100a	97a	60a	35
23.	Oryzalin (Surflan 4AS) + diuron (Karmex 80W)	4.0 + 1.0	43a	98a	100a	37b	28
24.	Pendimethalin (Prowl 4E)	0.75	54b	88a	57c	35b	12
25.	Pendimethalin (Prowl 4E)	1.5	46a	93a	58c	38b	20
26.	Paraquat (Ortho Paraquat) only	0.5	77b	83a	13d	25b	13
27.	Paraquat (Ortho Paraquat) only	1.0	74b	82a	7d	25b	43
28.	Simazine (Princep 4L)	3.0	38a	100a	84a	58a	35
29.	Diuron (Karmex 80W)	3.0	60b	97a	77b	35b	23
30.	Untreated	-	76b	42b	0d	28b	26

[a]Plots were also treated with the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant on April 21, 1982 to burn back existing vegetation.

[b]Means within a column followed by the same letter are not significantly different at the 5% level according to the Scott Knott test; ns denotes no significant difference among all treatments.

[c]Anbl = Annual broadleaf; Angr = Annual grass; Prbl = Perennial broadleaf; and Prgr = Perennial grass.

wide spectrum of weeds later developed in the checks, including the annual grasses, their growth was less vigorous than that in the treated plots. Their less vigorous growth probably reflects the rye's initial occupation of the site and strong competitive ability for water, nutrients, and light.

The best treatments were combinations of herbicides with either simazine or diuron. These gave a broader spectrum of control as well as better residual activity. When the plots were observed on July 29, 1982, the napropamide and either simazine or diuron combinations provided the greatest weed suppression. Judging from the percent groundcover, the 1.2 kg/ha rate of simazine or diuron may be too low. The following treatments showed good early annual grass control: napropamide (4.5 kg/ha), diphenamid (6.7 kg/ha), norflurazon (2.2 kg/ha) oryzalin (2.2 kg/ha), and simazine (3.4 kg/ha). However, after a three month period, their activity was fading, particularly in the case of metolachlor. Pendimethalin was noticeably weaker on the annual grasses. The reason was not evident, because adequate rainfall was received within the first week after application.

There were no significant differences in new shoot growth or scion circumference (Table 6). There are several possible reasons for this. The lack of great contrast in

Table 6. Effect of herbicides on total length of new shoot growth and scion circumference growth for the 1982 growing season in 'Red Chief' (Red Delicious) apples. Daleville, Virginia. Treated April 22, 1982 with preemergence (residual) herbicides.[a] Data are averages of six replicates[b].

Treatment	Rate	New shoot growth 1982 season	New scion circumference growth[c] 1982 season
	(lb ai/A)	(cm)	(cm)
1. Metolachlor (Dual 8E)	2.0	505	2.3
2. Metolachlor (Dual 8E)	3.0	432	2.5
3. Napropamide (Devrinol 50W)	4.0	300	2.1
4. Napropamide (Devrinol 50 WP) + simazine (Princep 4L)	4.0 + 1.0	434	2.3
5. Napropamide (Devrinol 50 WP) + diuron (Karmex 80W)	4.0 + 1.0	478	2.7
6. Diphenamid (Enide 50W)	4.0	313	2.3
7. Diphenamid (Enide 50W)	6.0	236	1.9
8. Oxyfluorfen (Goal 2E)	1.0	312	2.0
9. Oxyfluorfen (Goal 2E)	2.0	262	1.9
10. Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	1.0 + 1.0	312	2.1
11. Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	2.0 + 1.0	299	2.2
12. Oxyfluorfen (Goal 2E) + diuron (Karmex 80W)	2.0 + 1.0	329	2.1
13. Norflurazon (Solicam 80W)	2.0	334	2.1
14. Norflurazon (Solicam 80W)	4.0	284	1.9
15. Norflurazon (Solicam 80W)	6.0	267	1.9
16. Norflurazon (Solicam 80W) + simazine (Princep 4L)	2.0 + 1.0	388	2.2
17. Norflurazon (Solicam 80W) + simazine (Princep 4L)	4.0 + 1.0	361	2.3
18. Norflurazon (Solicam 80W) + diuron (Karmex 80W)	4.0 + 1.0	179	1.7
19. Oryzalin (Surflan 4AS)	2.0	340	2.2
20. Oryzalin (Surflan 4AS)	4.0	466	2.4
21. Oryzalin (Surflan 4AS) + simazine (Princep 4L)	2.0 + 1.0	414	2.1
22. Oryzalin (Surflan 4AS) + simazine (Princep 4L)	4.0 + 1.0	361	2.2
23. Oryzalin (Surflan 4AS) + diuron (Karmex 80W)	4.0 + 1.0	305	2.2
24. Pendimethalin (Prowl 4E)	0.75	299	2.0
25. Pendimethalin (Prowl 4E)	1.5	375	2.1
26. Paraquat (Ortho Paraquat) only	0.5	315	2.1
27. Paraquat (Ortho Paraquat) only	1.0	294	2.1
28. Simazine (Princep 4L)	3.0	280	1.8
29. Diuron (Karmex 80W)	3.0	443	2.3
30. Untreated	-	211	1.5

[a]Plots were also treated with the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant on April 21, 1982 to burn back existing vegetation.

[b]Means within a column were not significantly different at the 5% level according to the Scott Knott test.

[c]Current season's scion circumference growth measured 5 cm above the scion/stock graft line.

weed control effectiveness, as well as the lack of several excellent treatments is one factor. The great number of site variables, such as differences in moisture, light, and weed spectrum within the field is a second. Thirdly, the trees differed in their initial vigor. As with the previous test, there was no outward evidence of herbicide injury to the young trees.

Experiment 4

When the plots were observed on July 29,1982, the treatments with the greatest residual activity were the metolachlor and 3.6 kg/ha rate of simazine combinations (Table 7). Annual weed control was excellent. Common lambsquarters, annual fleabane, Virginia pepperweed, horseweed, prickly lettuce, and large crabgrass were present in the untreated checks as well as in small numbers in certain treated plots. The escaped perennials included johnsongrass, dandelion, common milkweed and broadleaf dock. The low percent groundcover ratings for the metolachlor and simazine combinations, 9% and 13%, indicate their effective early-season weed control. Several other treatments provided excellent annual weed control. These included combinations of simazine or diuron with either napropamide, oxyfluorfen, or norflurazon as well as simazine or diuron

Table 7. Effect of herbicides on percent groundcover, scion circumference for the 1982 growing season and tree height measurement in one-year-old peaches. Daleville, Virginia. Treated April 29, 1982 with preemergence (residual) herbicides.[a] Data are averages of five replications.[b]

Treatment	Rate	Groundcover June 9, 1982	New scion circumference growth[c] 1982 season	Tree height April 29, 1982
	(lb ai/A)	(%)	(cm)	(cm)
1. Metolachlor (Dual 8E)	2.0	28b	8.6a	84 ns
2. Metolachlor (Dual 8E)	3.0	22b	9.0a	87
3. Napropamide (Devrinol 50 WP)	4.0	17a	8.5a	89
4. Napropamide (Devrinol 50 WP) + simazine (Princep 4L)	4.0 + 1.0	8a	9.0a	79
5. Napropamide (Devrinol 50 WP) + diuron (Karmex 80W)	4.0 + 1.0	10a	9.1a	81
6. Diphenamid (Enide 50W)	4.0	34b	9.0a	89
7. Diphenamid (Enide 50W)	6.0	31b	7.7b	78
8. Oxyfluorfen (Goal 2E)	1.0	8a	8.0a	78
9. Oxyfluorfen (Goal 2E)	2.0	6a	8.4a	90
10. Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	1.0 + 1.0	3a	8.9a	83
11. Oxyfluorfen (Goal 2E) + simazine (Princep 4L)	2.0 + 1.0	6a	8.3a	85
12. Oxyfluorfen (Goal 2E) + diuron (Karmex 80W)	2.0 + 1.0	12a	7.3b	85
13. Norflurazon (Solicam 80W)	2.0	28b	7.7b	78
14. Norflurazon (Solicam 80W)	4.0	28b	6.7b	84
15. Norflurazon (Solicam 80W)	6.0	17a	8.2a	83
16. Norflurazon (Solicam 80W) + simazine (Princep 4L)	2.0 + 1.0	8a	8.2a	82
17. Norflurazon (Solicam 80W) + simazine (Princep 4L)	4.0 + 1.0	15a	8.3a	88
18. Norflurazon (Solicam 80W) + diuron (Karmex 80W)	4.0 + 1.0	24b	8.2a	85
19. Oryzalin (Surflan 4AS)	2.0	27b	7.8a	80
20. Oryzalin (Surflan 4AS)	4.0	21b	9.8a	84
21. Oryzalin (Surflan 4AS) + simazine (Princep 4L)	2.0 + 1.0	33b	8.4a	81
22. Oryzalin (Surflan 4AS) + simazine (Princep 4L)	4.0 + 1.0	30b	7.0b	80
23. Oryzalin (Surflan 4AS) + diuron (Karmex 80W)	4.0 + 1.0	41b	7.5b	80
24. Pendimethalin (Prowl 4E)	0.75	11a	9.4a	91
25. Pendimethalin (Prowl 4E)	1.5	30b	7.9a	87
26. Paraquat (Ortho Paraquat) only	0.5	77c	7.2b	82
27. Paraquat (Ortho Paraquat) only	1.0	74c	6.3b	85
28. Simazine (Princep 4L)	3.0	7a	8.4a	85
29. Diuron (Karmex 80W)	3.0	12a	8.8a	83
30. Metolachlor (Dual 8E) + simazine (Princep 4L)	2.0 + 1.0	24b	10.1a	82
31. Metolachlor (Dual 8E) + simazine (Princep 4L)	2.0 + 3.0	9a	9.4a	87
32. Metolachlor (Dual 8E) + simazine (Princep 4L)	3.0 + 1.0	21b	10.5a	81
33. Metolachlor (Dual 8E) + simazine (Princep 4L)	3.0 + 3.0	13a	10.6a	88
34. Untreated	-	94d	5.7b	87

[a]Plots were also treated with the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant on April 30, 1982 to burn back existing vegetation.

[b]Means within a column followed by the same letter are not significantly different at the 5% level according to the Scott Knott test; ns denotes no significant differences among all treatments.

[c]Current season's scion circumference growth measured 5 cm above the scion/stock graft line.

applied singly at the 3.6 kg/ha rate. The napropamide combinations and oxfluorfen applied singly showed less residual activity than the others after three months. Prickly lettuce and common lambsquarters, which are normally controlled by napropamide, were present in the plots. The activity of napropamide may have been diminished by the lack of rainfall. The perennials found in these plots included white clover, common yellow woodsorrel, horsenettle, and broadleaf dock. Johnsongrass and horseweed, two vigorous species, were both stunted at the 2.3 kg/ha rate of oxyfluorfen. Neither oryzalin nor diuron provided the expected weed control when used in combination at the 4.6 + 1.2 kg/ha rates. The lack of rainfall and the low rate of diuron were probable contributing factors. When diuron was applied at a higher rate (3.6 kg/ha), the annual grass control was good. The activity of norflurazon was also probably lessened by the lack of rainfall. Both common lambsquarters and horseweed, two weeds normally controlled, were present in the plots.

There was a rye groundcover present in the untreated checks, but the weed suppression seen in Experiment 3 was not as evident. Annual grasses, as well as a broad range of perennials were present including common yellow woodsorrel, ground cherry (Physalis spp.), dandelion, and johnsongrass.

It is possible the rye groundcover was sparser in this experiment.

There were significant differences in the scion circumference growth for the 1982 growing season (Table 7). The most effective herbicide treatment, the metolachlor and simazine combination resulted in the greatest scion circumference growth, almost twice that of some of the untreated checks. The approximate tree height measurement indicated there were no significant differences in the original tree size. The occasional leaf chlorosis seen in the field appeared to be more related to soil, tree size and vigor than treatment, because chlorosis was apparent only in one replication of a treatment. This occurred for example, with the highest rate of diuron. In another instance, a loosely planted tree became very chlorotic after the herbicide came into direct contact with the tree roots. This indicates fruit trees must be properly planted and maintained to avoid injury from herbicides.

Glyphosate injury symptoms were evident on several peach trees on July 29, 1983. This was apparently the result of the glyphosate wick occasionally touching the lower branches. Dead buds and foliage were present on adjoining branches that had been affected when the chemical translocated. This confirms previous work that stressed the importance of avoiding contact with the tree foliage.

Experiment 5

All of the treatments in Experiment 5, which consisted of different combinations of metolachlor and simazine provided excellent control of annual grasses (Table 8). The escaped species were perennials such as johnsongrass, broadleaf dock, white clover and buckhorn plaintain. The higher rate of simazine provided significantly better residual activity when the plots were examined after a three month period. Weed control ranged from 80 to 98% in comparison to 0% weed control for the untreated check. The check contained a wide spectrum of weeds including annual grasses, Virginia pepperweed, Pennsylvania smartweed, johnsongrass, white clover, poison ivy, buckhorn plaintain, and common yellow woodsorrel. The rye covercrop did not appear to control the perennial weeds present in this experiment.

The excellent weed control ratings were not reflected in significant differences in new shoot or scion circumference growth for the 1982 growing season (Table 9). However, the best treatment did show the greatest growth. It is possible the herbicide treatments were applied too late in the season to see any significant differences in growth. It also is possible that although the rye groundcover did not control the weed growth, it suppressed the weed size to the extent that significant differences in tree growth were not

Table 8. Effect of herbicides on percent weed control in 'Red Chief' (Red Delicious) apples. Daleville, Virginia. Treated May 5, 1982 with preemergence (residual) herbicides.[a] Data are averages of six replications.[b]

Treatment	Rate	Weed control					
			June 25, 1982				
		June 9, 1982	Anbl[c]	Angr	Prbl	Prgr	July 29, 1982
	(lb ai/A)	(%)	(%)				(%)
1. Metolachlor (Dual 8E) + simazine (Princep 4L)	2.0 + 1.0	78a	98a	88a	85a	63b	81c
2. Metolachlor (Dual 8E) + simazine (Princep 4L)	2.0 + 3.0	78a	99a	98a	88a	93a	97a
3. Metolachlor (Dual 8E) + simazine (Princep 4L)	3.0 + 1.0	79a	100a	90a	88a	85a	87b
4. Metolachlor (Dual 8E) + simazine (Princep 4L)	3.0 + 3.0	72a	98a	100a	80a	93a	98a
5. Untreated	-	21b	48b	28b	43b	23c	0d

[a]All sprays also contained the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant to burn back existing vegetation.

[b]Means within a column followed by the same letter are not significantly different at the 5% level according to the Scott Knott test.

[c]Anbl = Annual broadleaf; Angr = Annual grass; Prbl = Perennial broadleaf; Prgr = Perennial grass.

Table 9. Effect of herbicides on total length of new shoot growth and scion circumference growth for the 1982 growing season in 'Red Chief' (Red Delicious) apples. Daleville, Virginia. Treated May 5, 1982 with preemergence (residual) herbicides.[a] Data are averages of six replications.[b]

Treatment	Rate	New shoot growth 1982 season	New scion circumference growth[c] 1982 season
	(lb ai/A)	(cm)	(cm)
1. Metolachlor (Dual 8E) + simazine (Princep 4L)	2.0 + 1.0	332	1.6
2. Metolachlor (Dual 8E) + simazine (Princep 4L)	2.0 + 3.0	315	1.7
3. Metolachlor (Dual 8E) + simazine (Princep 4L)	3.0 + 1.0	386	1.9
4. Metolachlor (Dual 8E) + simazine (Princep 4L)	3.0 + 3.0	460	2.1
5. Untreated	-	347	2.0

[a]All sprays also contained the postemergence (contact) herbicide paraquat (561 g/ha) plus Ortho X-77 surfactant to burn back existing vegetation.

[b]Means within a column were not significantly different at the 5% level according to the Scott Knott test.

[c]Current season's scion circumference growth measured 5 cm above the scion/stock graft line.

evident. Site variables, as well as individual tree vigor, could possibly influence the tree growth to a greater extent than the herbicide treatments.

SUMMARY

The weed control ratings and observations in all five experiments showed a broader spectrum of control can be achieved with herbicides used in combination. A common phenomenon observed over all the tests was the release of perennial species, particularly broadleaf species, when the annuals were suppressed. Rupp and Anderson (74) reported a similar weed species shift from grasses to primarily broadleaf species with the use of herbicides. This indicates the importance of controlling perennial species prior to the orchard establishment. It also suggests the need for spot treatments, such as the glyphosate wick method that was utilized in these experiments to control johnsongrass, as well as alternative methods of chemical control, for example the use of groundcovers with allelopathic properties. Many of the treatments provided satisfactory annual grass control, but the perennial weed problem remained.

There were only a few incidences of injury to the young trees from the herbicides. This suggests it may be feasible to expand the label for some of these products, although this conclusion can not be made without further investigation. The product oxyfluorfen, not currently registered for fruit in Virginia, looked particularly promising for its ability to increase the spectrum of annual broadleaf weeds controlled.

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VEGETATION MANAGEMENT EFFECTS ON FRUIT TREES

PART I -- Vegetation Management Effects on Tree Growth: An Overview

PART II -- Effect of Selected Preemergence Herbicides on Early Season Weed Control and Shoot Growth of Newly Planted Apples and Peaches

by

Susan Beth Harrison

ABSTRACT

PART I:

The orchard floor is managed to provide satisfactory conditions for both the tree root system and farm machinery. The choice of a particular system to achieve this aim depends on a number of factors. The topography and climate of the orchard site are considered. The influence of the orchard floor management system on the soil condition, moisture and nutrient availability, beneficial soil fauna, pest/predator complexes, the fruit tree nutritional status, and weed suppression through possible allelopathic affects are also taken into account.

PART II:

Eleven preemergence herbicide treatments were applied at two commercial orchards, located in Hoges Chapel,

Virginia and Daleville Virginia to evaluate the influence of the treatments on weed control and new shoot growth of newly transplanted and one-year-old apple and peach trees. The weed control ratings and observations showed that a broader spectrum of control could be achieved with a combination of herbicides than with any herbicide applied alone. The control of annual weed species was excellent with several treatments, but the use of certain herbicides appeared to release a number of perennial species. Consequently, season long control was often not achieved. There were few indications of any herbicide injury to the young trees.