C. Lewis

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

September 19, 1988

MEMORANDUM

SUBJECT: Transmittal of Qualitative Use Assessment (QUA) for Benefin (084301)

FROM: James G. Saulmon, Ph.D., Botanist
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Biological and Economic Analysis Division (TS-768C)

TO: ADDRESSEES

THRU: Janet L. Andersen, Ph.D., Acting Section Chief
Plant Sciences Section
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Biological and Economic Analysis Division (TS-768C)

Attached is the QUA for Benefin. The information in this report is current as of 09/19/88. This report contains no Section 7 or company submitted data classified as CBI.

If there are any questions, please contact me in Room 1024A, on 557-1774.

Attachment

ADDRESSES

Brigid Lowery, MSS/HED
Bob Taylor, PM-25/RD
Bill Phillips, BAB, BEAD
Arnold Aspelin EAB, BEAD

QUALITATIVE USE ANALYSIS OF THE

HERBICIDAL USES OF

BENEFIN

[N-BUTYL-N-ETHYL-ALPHA,ALPHA, ALPHA-TRIFLUORO-2,6-DINITRO-P-TOLUIDINE]

(084301)

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September 19, 1988

TABLE OF CONTENTS

I. INTRODUCTION

Benefin is a preemergent herbicide which, after being applied, must be soil incorporated within either 4 hours in the Western United States or 8 hours in the Easter United States (Beste, 1983). Benefin may be applied and incorporated at the windows of either preplant or postplant (Beste, 1983). In most agricultural practices, benefin is used as a soil incorporated, preemergence herbicide and is not normally applied to plant foliage (Beste, 1983). The usual carrier of emulsifiable concentrates of benefin is water at 5 to 40 gallons per acre (Beste, 1983). Benefin may also be applied in liquid fertilizers (Beste, 1983).

A. Chemical characteristics

Benefin is a dinitroaniline herbicide (Kempen, 1987).

B. Herbicidal activity

1. Mode of Action

Benefin does not directly inhibit the seed germination process; however, it affects physiological growth processes associated with seed germination (Beste, 1983).

2. Behavior in soils

Benefin is strongly absorbed on soil and shows negligible leaching (Beste, 1983). Moreover, organic matter and clay content of the soil influence the application rate of benefin used to achieve herbicidal activity (Beste, 1983).

3. Breakdown of benefin

Benefin applied at recommended rates provides season-long weed control (Beste, 1983). Indirect evidence suggests that microorganisms play a role in the disappearance of benefin from the soil (Beste, 1983). Benefin is slightly volatile (Beste, 1983). Benefin persists in the soil approximately 120 to 150 days which represent the time required for bioactivity to indicate 90% loss of herbicide based on bioassays or residue analysis from normal rates applied under normal agricultural conditions (Kearney, 1977).

II. REGISTRATION SUMMARY

Benefin is registered for use on terrestrial nonfood crops including agricultural crops (tobacco), and ornamental plants and forest trees including established ornamental plantings (25 species), established turfgrasses (10 species) such as golf course turf, lawns, and ornamental turf. Also, benefin may be applied to the following terrestrial food crops: alfalfa, clover (alsike, birds-foot, ladino, and red), lettuce (direct-seeded), and peanuts.

Ranges of application rates for the site groups are listed below:

Terrestrial Food Crops	
agricultural crops	1.1 to 1.5 lbs AI/A
Terrestrial Nonfood Crops	
agricultural crops (tobacco)	1.1 to 1.5 lbs AI/A
ornamental plants and forest trees	0.07 to 0.40 lbs AI/5,000 sq. ft.
turf and established turfgrass	0.23 to 0.34 lbs AI/5,000 sq. ft.

Based on the Index, benefin may be applied by ground equipment via the types of application for site categories listed below:

A. preplant, soil incorporated, broadcast, or band to: alfalfa (& clovers), lettuce, and peanuts.
B. preplant, soil incorporated, spreader application, broadcast or band to: peanuts and tobacco.
C. pretransplant, soil incorporated, broadcast or band to: tobacco.
D. soil incorporated, spreader application, broadcast, to: ornamental plants and forest trees (25 species).
E. spreader or sprayer application, broadcast, (two-pass crisscross application) to: turfgrasses (10 species).
F. spreader application, broadcast to: established turfgrass (10 species), (includes professional use only).
G. hose-end sprayer application, broadcast to: established turfgrasses (10 species).
H. spreader application to: golf course turf, lawns, ornamental turf, (includes professional use only).

Benefin may be applied by air to peanuts. Benefin may be tank-mixed with metolachlor and vernam for use on peanuts.

III. USE SUMMARY

The PQUA for benefin includes the following use estimates: 40 percent on turf and landscape; 40 percent on home and garden (home lawns); 20 percent on agricultural crops (peanuts, alfalfa, tobacco); California ranked first in use on alfalfa and lettuce).

A. Terrestrial Food Crops (alfalfa,lettuce, peanuts)

1. Alfalfa

Benefin, applied preplant incorporated (PPI) in alfalfa, is recommended for use in AZ, AR, CA, OK, MS, NM, NY, OR, WA, WV, and WY at rates of 1.1 to 1.5 lbs AI/A. The lower rates are recommended for use on course and medium soils while the higher rates are for fine soils (Baldwin., et al., 1988; Boyd and Gardisser, 1984; Burrill, et al., 1988; Hahn and Linscott, 1988; Heathman and Tickes, 1984; Houston, 1988; Lee, et all, 1987; Mitich, 1981; OSU Coop. Ext. Serv., 1988; Parker, 1982; Sanders, et al., 1988; Sperow, 1979; Whitson, et al., 1988).

State recommendations for Oregon and Washington give the following rotational crop restrictions for benefin used on alfalfa [paraphrased as follows]:

a. Do not plant wheat, barley, rye, other domestic grasses or onions following applications for 10 months; and
b. Do not plant milo (grain sorghum), corn, oats, red beets, sugar beets, other root crops or spinach following application for 12 months (Burrill, et al., 1988; Parker, 1982).

A study of benefin weed control in irrigated seedling alfalfa was done in western Nebraska (Wilson, 1986). Results of this study suggested that benefin applied at 1.0 lb/A followed by postemergence application of 2,4-DB were more effective in controlling grasses than fluazifop-butyl and sethoxydim combined with 2,4-DB or bromoxynil (Wilson, 1986). Also noted in the study, benefin applied preplant at 1.0 lb/A and at 1.4 lb/A preplant injured the alfafla, but, by time for the second cutting, the alfalfa had grown out of the injury (Wilson, 1986). In addition, alfalfa seedlings having adequate moisture may not suffer the deleterious effects to stand and forage yield caused by annual weeds (Wilson, 1986).

In the San Joaquin Valley of California, benefin (Balan 60% DF) is the best option for preplant residual control in January to April plantings of alfalfa if summer grasses and pigweeds are anticipated (Kempen, 1987). Benefin, water dispersable formulation, provides about 4 to 5 months of control, thus it is more logical to use it in spring rather than in October plantings of alfalfa (Kempen, 1987). In the San Joaquin Valley of California benefin has an activation without loss (AWOL) value of about 0.16 day, [or, unless moisture is added to activate it, benefin loses its activity within 0.16 day after it is applied] (Kempen, 1987). Benefin controls chickweed and knotweed, gives fair control of fiddleneck, fat-hen and Russian thistle (Kempen, 1987). Best soil incorporation of benefin is done by disc set 4 to 6 inches deep at a speed of 4 to 6 miles per hour; the finishing disc should be run in two directions (Kempen, 1987).

1. Alfalfa (Cont.d)

Benefin controls all winter grasses except wild oats and volunteer cereals and also gives fair control of fiddleneck and bromegrasses (Kempen, 1987). Benefin may be applied preplant, at any time after January 1 before seeding to red clover, birdsfoot trefoil, alside clover, ladino clover as well as alfalfa at 1.125 to 1.5 lbs AI/A to control annual grasses and broadleaf weeds (Boettger, 1988). Benefin should be incorporated once within one day after application and again any time before planting (Boettger, 1988).

Risk to alfalfa is increased with surface applications of benefin (Kempen, 1987). Benefin generally has excellent safety if it is incorporated 1.5 to 3 in deep and moisture is adequate (Kempen, 1987). The greatest risk (to the crop) is when alfalfa plantings are made in treated soil anticipating winter rains which do not come, therefore, pre-irrigation is recommended (Kempen, 1987).

Benefin (Balan 60% DF) at 1.2 to 1.5 lbs AI/acre is listed as a PPI option for use in new plantings of forage alfalfa (San Joaquin Valley, California) in January to April (Kempen, 1987). The competitiveness of forage alfalfa and monthly mowings make it formitable against weeds (Kempen, 1987). Fall plantings of alfalfa often do not need a benefin (preplant) treatment if the crop has been grazed by sheep in late January (Kempen, 1987). From September to October, in exceptional cases, benefin (preplant) may be needed when winter annual grasses, fiddleneck or chickweed are expected (Kempen, 1987).

2. Lettuce

Benefin may be applied preplant to lettuce at the rate of 1.12 to 1.5 lb AI/A before seeding (but not after seeding) to control annual grasses and broadleaf weeds. It is incorporated one time within 8 hours after application and again any time before planting (Boettger, 1988).

Benefin, applied PPI in lettuce, is recommended in LA, NM, NY, OK, and OR at 1.1 to 1.5 lbs AI/A for weed control (Bellinder, et al., 1988; Burrill, et al., 1988; Lee, et al., 1987; OSU Coop. Ext. Serv., 1988; Sanders, et al., 1988). In the Pacific Northwest, benefin may be applied, for example, through center pivot and lateral-move irrigation systems to direct-seed lettuce (Buerrill, et al., 1988). Moreover, benefin rates of 1.1 to 1.5 lbs AI/A may be applied from 10 weeks to immediately before planting lettuce and incorporated within 8 hours by cross-disking or power take off (PTO) rotary tilling (Burrill, et al., 1988).

Benefin, for primary treatment at planting, is used at 1.08 to 1.5 lbs AI/A (Balan 60% WDG) applied PPI with pronamide (Kerb 50 W) at 1 to 2 lbs preemergence; or benefin (Balan 60% WDG) at 1.08 to 6.5 lbs AI/A plus Kerb 50-W at 1 to 2 lbs AI/A shallow PPI (Kempen, 1987). Benefin sprays are immediatedly incorporated into preformed lettuce bed or are applied prior to forming beds and disced in (Kempen, 1987). Benefin plus pronamide, the most widely used residual application in lettuce in California, works best if benefin is applied preplant incorporated, followed by surface-applied pronamide after planting and immediately sprinkled with water (Kempen, 1987). Although the combination of benefin and pronamide controls most weeds in lettuce, the following weeds were not affected: prickly lettuce, horseweed (marestail), fleabane, cudweed, groundsel, sowthistle, perennial broadleaf weeds, nutsedges, annual clovers and filaree (Kempen, 1987).

2. Lettuce (Cont.d)

Lack of weed control by benefin occurs when soils are exceptionally dry (Kempen, 1987). On sandy loam soils one disking followed by bed forming and tillage will suffice, but on loams (where most of the lettuce is grown) two diskings enhance the percentage of weed control by benefin (Kempen, 1987). Weed control is improved if benefin, applied after beds are formed is roto-tilled in about three inches (Kempen, 1987). When disking, higher label rates of benefin are preferred, and on clay loams higher label rates are essential (Kempen, 1987).

Although lettuce is quite tolerant to benefin, some retardation of lettuce is expected at benefin "2X" rates (Kempen, 1987). Lettuce is injured if benefin is applied pre-emergence (Kempen, 1987). An alternative treatment may be used: a mix of benefin 1.08 to 1.5 lbs AI/A (Balan 60% WDG) plus Chem Hoe FL4 at the rate of 3 to 4 lb AI/A incorporated (just preplant); or benefin (Balan 60% WDG) at the rate of 1.08 to 1.5 lb AI/A alone applied PPI (Kempen, 1987).

As a crop protection chemical, benefin may be combined with propham (Chem Hoe 4F) to control volunteer cereals and winter grasses (Kempen, 1987). Beds are usually shaped first and then the combination is mulched (tilled) in two to three inches deep (Kempen, 1987). Usually it is not logical in California to use benefin by itself because the combination of benefin plus pronamide controls enough weed species to be cost-effective compared to handweeding (Kempen, 1987). Only on summer plantings of lettuce where no nightshades, London rocket or shepardspurse are expected is use of benefin alone reasonable (Kempen, 1987). In the San Joaquin Valley, London rocket, and shepardspurse will germinate and nightshade is usually present, thus the combination of benefin and pronamide is preferred on July plantings of lettuce (Kempen, 1987).

Benefin (Balan 60% AI) may be applied by air or ground, has an activation without loss (AWOL) value (after applying) of 1/6 day (Kempen, 1987). Benefin has an expected persistence (in the soil at crop use rates) of three to six months (Kempen, 1987).

3. Peanuts

Benefin has been registered for use on peanuts since 1966 (Burnside, et al., 1982). Benefin may be applied at the rate of 1.2 to 1.5 lb AI/A (a preplant or at planting) at any time up to 10 weeks before planting or at planting control annual grasses and broadleaf weeds (Boettger, 1988). In 1982, benefin was applied at 1.12 to 1.5 lb AI/A to 97% of treated peanuts in Alabama, Florida, and Georgia (Burnside, et al., 1982). Benefin (Balan 1.5 LC), applied PPI on peanuts, is recommended for use in Alabama and New Mexico at rates of 1.1 to 1.5 lbs AI/A (Everest, et al., 1980; Lee, et al., 1987).

Most peanuts in Georgia are planted from early May to late June, therefore, the time between Spring applications of benefin and the appearance of a rotational crop seedlings, such as soft red winter wheat, is 150 to 210 days (Banks, 1986). The lowest rate of benefin applied at 1.5 lb AI/A on peanuts did not injure wheat or corn which were planted in rotation to peanuts (Banks, 1986). On the other hand, efforts to control Texas panicum in peanuts by using high rates of benefin at 3.0 to 6.1 lbs AI/A had a potential to injure wheat or corn planted in the Fall or Spring (Banks, 1986).

3. Peanuts (Cont.t)

Benefin may be applied either alone or in tank mixes for weed control in peanuts (Boettger, 1988). Benefin may be tank-mixed at the rate of 1.2 to 1.5 lb AI/A with metolachlor (Dual 8E) at preplant 1.5 lb to 3 lbs AI/A, or with Vernolate (Vernam 7E) at (preplant or at planting) 2.0 to 2.6 lbs AI/A (Boettger, 1988). Benefin (Balan 1.5 EC or DF), may be applied PPI at 1.12 to 1.5 lb AI/A within two days after planting using either center pivot or continuous lateral move irrigation systems to control annual grasses and broadleaf weeds (Boettger, 1988).

A study in the Southeastern Plains was done on benefin applied through center pivot irrigation systems. Results suggested that benefin gave weed control which was equal to or greater than its control through conventional systems with apparently no effect on peanut yield (Dowler and Scott, 1981).

Terrestrial Nonfood crops

1. Tobacco

Benefin may be applied (pretransplant, and must be incorporated before transplanting) at 1.12 to 1.5 lb AI/A for use on burley and dark tobacco to control annual grasses and broadleaf weeds (Boettger, 1988). Benefin may be applied (pretransplant, at any time within 10 weeks before transplanting, and must be incorporated) at 1.12 to 1.5 lb AI/A for use in burley tobacco (Boettger, 1988).

2. Ornamental Plants and Established Turfgrass

Benefin will kill grass seedlings and thus should be applied to established grasses.

Benefin, applied preemergence in turfgrasses to control annual grasses, is recommended in Arkansas, Florida, New Mexico and Texas to control grasses infesting turfgrasses (Baldwin, et al., 1988; Campbell, 1985; Green, et al, 1987; Lee, et al., 1987; McCarty and Colvin, 1988; Palmer, 1988; Sanders, et al., 1988; Taylor, 1986).

Benefin, applied preemergence (usually in May), was recommended in Minnesota to control annual grasses, such as, barnyardgrass, annual bluegrass, crabgrass, and foxtail (Ascerno, et al., 1982). Turf should not be reseeded for 6 to 8 weeks after application (Ascerno, et al., 1982).

Benefin, for use in established warm- and cool-season turfgrasses, may be applied at the rate of 1.5 to 3 lbs AI/A prior to germination of annual grasses such as, crabgrass (Boettger, 1988). Benefin may be applied again in 4 to 6 weeks to control goosegrass and applied in late Summer or early Fall to control annual bluegrass (Boettger, 1988). Benefin may be used to control annual grasses, such as, annual bluegrass, barnyardgrass, crabgrass (hairy and smooth) foxtails (green and yellow), and goosegrass (Boettger, 1988). Benefin should not be used on dichondra or bentgrass and the turfgrasses should not be reseeded within 42 days after treatment (Boettger, 1988). Spring applications of benefin to perennial ryegrass and bluegrass, when compared to fall applications, gave better control of crabgrass (Vitolo, et al., 1986).

2. Ornamental Plants and Established Turfgrass (Cont.d)

Benefin and benefin plus trifluralin, according to results of two experiments done on cool season turfgrass, provided at least 90% control of smooth crabgrass (Watschke and Hamilton, 1985).

Results of another study suggested that benefin degraded faster in thatch than in soil from a Kentucky bluegrass turf (Hurto, et al., 1979). Thus, benefin treatments made to thatch would have to be either at higher rates or at more frequent intervals to achieve season-long control (Hurto, et al., 1979).

Results of field trials by Lilly Research Laboratories conducted on Team® (benefin 1.33% + trifluralin 0.67%) suggested that Team® applied: (1) at 2.0 lb/A in cool season turfgrass provided good to excellent control of crabgrass and goosegrass; and (2) at 2.0 to 3.0 lb/A in warm season turfgrass gave good to excellent control of crabgrass and fair control of goosegrass (Ortega, et al., 1986). Benefin has consistently given good preemergence control of annual weedy grasses in turf (Vengris, 1973). Three benefin formulations [starch xanthide (sx), sludge polymer (sp), and commercial] were tested in the field, greenhouse and laboratory (Chalmers, 1986). Results of the tests suggested that: (1) sp increased turf (Kentucky bluegrass) injury; and (2) sx not only decreased injury but also provided large crabgrass control which was similar to that of commercial formulations (Chalmers, 1986).

Benefin is also registered for use on herbaceous and woody ornamental plants. The PQUA noted about 40% of usage of benefin was applied to turfgrass and other landscape plantings in eastern states and western states (Bacanai, 1986).

IV TABLES

On the pages that follow, note that Table I provides a summary of SLN label information; Table II gives a numerical tally of benefin end-use products; Table III gives a summary of general use patterns of benefin single active ingredients according to 40 CFR 158; and Table IV provides comments on the use profile of benefin.

Table I. Benefin. Summary of SLN Registrations for Food Crops

Site	Product rate (lbs AI/A)	Weeds Controlled	Comments
Peanuts (irrigated through center-pivot sprinkler systems)	Balan L.C. (benefin) Tank-mix with Vernam 7E. Apply at recommended rates with irrigation water after planting peanuts, but before weeds or crop emerge. Prepare a mixture with a minimum of 1 part Balan® and 1 part water. Inject this mixture into the center pivot system using a positive displacement pump. Apply in 0.3 to 1.0 inch of irrigation water/A.	Refer to labels for Balan® and Vernam for list of weeds which are controlled.	GA 810006 SLN for use in GA only. Parent label: EPA Reg. No. 1471-114. Soil surface should be well prepared, free of any existing weeds, trash or clods before application.
Peanuts (irrigated through center-pivot sprinkler systems).	Balan L.C. (benefin) Apply at recommended rates with irrigation water after planting peanuts, but before weeds or crop emerge. Inject into the center pivot system using a positive displacement pump. Apply in 0.3 to 1.0 inch of irrigation water/A.	Refer to Balan® label for weeds controlled.	GA 810007 SLN for use in GA only. Parent label: EPA Reg. No. 1471-114.

Table II. Benefin. Summary of End Use Products.

Registration Type	SAI	MAI	TOTAL
Sec. 3	131	76	207
Sec. 5	0	0	0
Sec. 18	0	0	0
Sec. 24C	2	0	2
Intrastate	0	0	0
Total	133	76	209

Sec. 3 = Federal Registrations
Sec. 5 = Experimental Use Permits
Sec. 18 = Emergency Exemptions
Sec. 24C = Special Local Need (SLN)

Note: On 09/01/88 All Benefin Intrastate labels were cancelled:

Table III. Benefin. Summary of General Use Patterns by Products (Single Active Ingredients Only) as Designated by 40 CFR Part 158 Pesticide Registration Data Requirements Registraions.

SITE CATEGORY	GENERAL USE PATTERN		
	TERRESTRIAL		
	Food Crop	Nonfood Crop	Ornamentals
Agricultural crops (e.g., lettuce, peanuts)	X		
Tobacco		X	
Established turfgrass (e.g., Bahiagrass)			X
Ornamental plants and forest trees (e.g., English Ivy, Juniper)			X

Table IV. Comments on Use Profile for Chemical Benefin.

B. Use Profile

Type of Pesticide:	preemergent herbicide, classified as a dinitroaniline.
Pests Controlled:	weeds: grasses, (includes, barnyardgrass, crabgrass, crowfootgrass, foxtail, goosegrass, johnsongrass, fall panicum, Texas panicum, ryegrass, and sandbur); broadleaves, (includes, carpetweed, chickweed, Desert rockpurslane, Florida pusley, knotweed, lambsquarters).
Registered Uses:	Terrestrial food crop use alfalfa, birdsfoot trefoil, clover (red, alsike, ladino), lettuce, and peanuts. Terrestrial nonfood crop use on tobacco (burley and dark); ornamental plants and forest trees (herbaceous and woody species); turfgrasses (includes, Bahiagrass, Bermudagrass, bluegrass, centipedegrass, fescue, Kentucky bluegrass, perennial ryegrass, ryegrass, St. Augustinegrass and Zoysiagrass).
Principle Uses:	Forty percent on turf and landscape; forty percent on home and garden (home lawns); 20 percent on agricultural crops (peanuts, alfalfa, tobacco); California ranked first in use on alfalfa and lettuce).
Method of application:	Preemergence soil application by ground equipment is the major method; incorporate prior to planting, seeding, transplanting of appropriate crops, or germination of grasses. Also may be applied by aerial equipment in peanuts.
Rates of application:	Terrestrial food crop: 1.1 to 1.5 lb AI per acre; Terrestrial nonfood agricultural crop: 1.1 to 1.5 lb AI/A; ornamental plants and forest trees: 0.23 to 0.34 lb AI/A per 5,000 sq. ft.; lawns, turf and established turfgrass: 0.04 to 0.34 lbs AI/A.
Formulations:	Tech. (93% AI), Formulation Intermediate (16.3 - 50% AI), Granular (0.29 - 2.06% AI), Wettable powder (0.75 - 21.8% AI); Dry Flowable (60%), Emulsifiable Concentrate (1.5 lb AI/gal, 21.78%), Soluble Concentrate/Liquid (1.5 lb AI/gal, 10 - 25%), Pressurized Liquid (11.48%).
Mode of Activity:	Affects physiological growth processes associated with seed germination and the inhibition of root and subsequent shoot growth.

C. Acceptable Ranges and Limits

3. Use Patterns:	The use patterns currently registered are terrestrial food crop, terrestrial nonfood crop, ornamental plants and forest trees, established turfgrasses, turf and lawns.

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