DUAL BOOM VERSUS SINGLE BOOM ZONE HERBICIDE APPLICATION (ZHA) IN FIELD CORN

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What is Reduced Rate-Zone Herbicide Application (ZHA)? Reduced-rate ZHA uses: 1) crop management to enhance crop competitiveness with weeds, 2) soil residual herbicide banded over crop rows at reduced rates (Figure 1) and 3) the same herbicide banded between rows at higher rates than in rows, but less than the maximum registered rate. The net result is that ZHA reduces total herbicide use per acre and herbicide input costs for farmers.

What Can Reduced Rate-Zone Herbicide Application Do for Farmers?
Economics:

- ZHA reduces total preemergence, soil residual herbicide use and herbicide input costs in competitive field crops without compromising net returns. For example in Missouri research, atrazine + s-metolachlor (e.g., Bicep II herbicide) use in field corn was reduced up to 47%, without reducing net returns.
- ZHA is best done at planting with special sprayer booms mounted on planter boxes. Cost savings on herbicides with ZHA quickly pay for spray boom construction. Spray boom construction is cheap, and sprayer parts are commercially available. ZHA sprayer calibration is simple.
- Reduced rate-ZHA of soil residual herbicides makes them be no more costly to farmers than herbicide-resistant GMO crops technology, without technology fees or restrictions on replanting saved seed.

Weed management:

- ZHA is an additional, alternative way to manage weeds which keeps decision making for weed management in the farmer's control, not commercial custom applicator.
- ZHA can be used on land with terraces, grassed waterways, or center pivot irrigation
- ZHA is a generic herbicide application method and can be used with many preemergence, soil residual herbicides in many row crops. It isn't limited only to atrazine + s-metolachlor (Bicep II) in corn.
- ZHA does not require major or expensive change to current weed management and crop production practices.
- Reduced-rate ZHA may slow selection and evolution of herbicide-resistant weeds.
- ZHA reduces the chance of herbicide damage to crops.

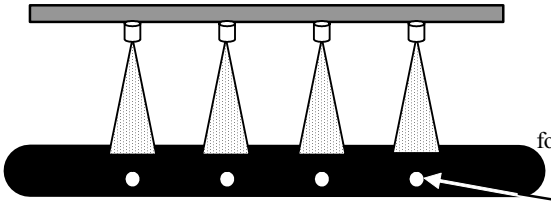
Herbicide contamination of water and water quality:

- By reducing herbicide use, ZHA helps reduce herbicide movement in runoff from fields and minimizes the chance of surface and ground water contamination by herbicides.
- By reducing water contamination by herbicides, public drinking water suppliers don't have the added cost of herbicide cleanup to comply with E.P.A. drinking water standards.

Reduces public fear and keeps herbicides on the market:

- By reducing reports of atrazine (Aatrex 4 L and numerous commercial herbicide mixtures containing atrazine) and other herbicides in drinking water, ZHA will reduce public fear of drinking water contamination by herbicides.
- In turn, this may help prevent these herbicides from being banned by government regulatory agencies. Thus, ZHA may help keep some herbicides on the market and available to farmers for weed management.

Even flat spray nozzle tips (all the same) (e.g., Tee Jet TP 4001 E)

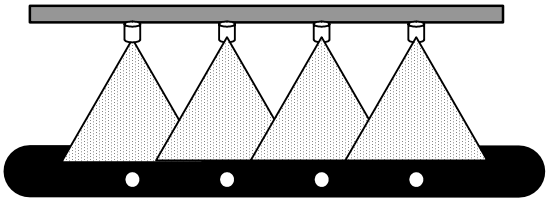


Band application
Premergence herbicide
is banded
over the crop row
followed by field cultivation
between rows later

This older herbicide spray
system was used for banding
preemergence herbicides
in the 1950's and 1960's.

Corn seed in 30 Inch rows

Standard flat spray tip (all the same) (e.g. Tee Jet TP 8002)

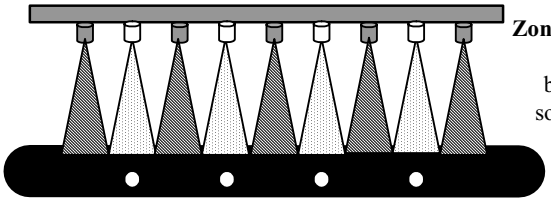


Broadcast application
Preemergence herbicide is
broadcast both over and
between crop rows

This conventional broadcast
herbicide spraying system
is used now.

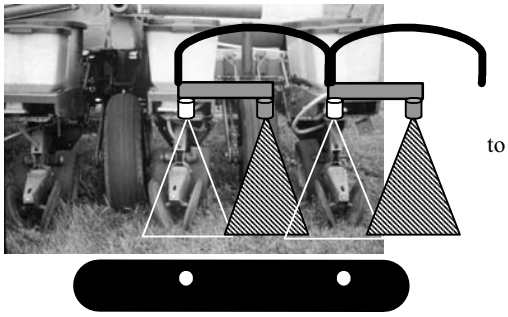
In Zone Herbicide Application (ZHA) different herbicide rates are applied between rows (BR) and in row (IR) using even nozzle tips and one spray boom so that The total amount applied is reduced up to 50% compared to broadcast treatments.

Different even flat spray nozzle tips with different output alternate in row and between row
(e.g., Tee Jet TP 4001 E in row and TP 4003 E between row)



Zone herbicide application (ZHA) with
premergence herbicide rates
between rows greater than in rows
so that less total herbicide is applied
less than broadcast treatments

This new adaptation
of older banding methods
has potential to
reduce herbicide inputs
for preemergence treatments
up to about 50%
without reducing $ returns



Zone herbicide application of preemergence herbicide
is best made at planting. Spray nozzles can be attached
to planter boxes so that herbicide is applied at different rates
in row and between row. This approach means that
zone herbicide application can be made on farmland
with terraces.

Herbicide is non-uniformly applied relative to the crop row, so that less is applied (up to 50% less) than when broadcast.

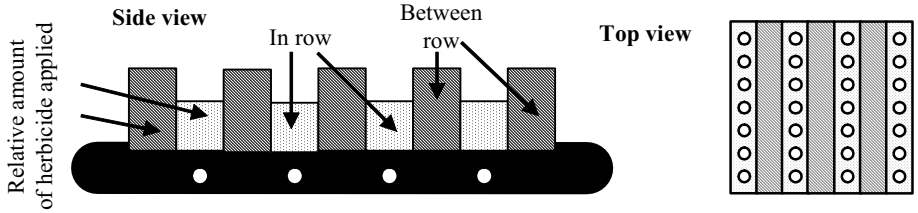


Figure 1. A comparison between band, broadcast, and zone herbicide application systems.

Background:
In previous research at UMC's Greenley and Bradford research centers, preemergence soil residual herbicides (chiefly, atrazine-metolachlor, as in Bicep II) were equally effective in controlling weeds whether they were broadcast applied or applied using zone herbicide application (ZHA) (i.e., lower rates over rows than between rows). Yields were equivalent with both application methods (equal to the weed-free checks), even though only 50 to 62.7% of the 1X broadcast herbicide rate was applied with zone herbicide application.

Although a dual boom system was used in this earlier zone herbicide application research, a single boom system for zone herbicide application would be mechanically simpler and less expensive. However, a modified calibration procedure would be needed for single boom zone herbicide application. In Feb. , 2002, W. Donald spoke before the advisory board for the Greenley research center. At that time, Rhett Hunziker (RR 1 Box 193, Knox City, MO 63446 (660) 434-5252) first suggested that a single boom ZHA might be feasible.

The characteristics of zone herbicide application with either dual booms or a single boom are compared with standard flat fan broadcast herbicide application in Table 1. The rate of herbicide application with broadcast or dual boom ZHA is determined by herbicide concentration in the spray tank after calibration, and other factors (e.g. carrier volume, speed, etc.) are held constant. Calibration procedures are the same for either broadcast application or dual boom ZHA systems. Coverage should be similar with either application method because they both use one type of nozzle, although there may be a greater chance for coverage problems with improper ZHA (Table 1). In contrast to dual boom ZHA, the herbicide rate for single boom ZHA is regulated by both (a) herbicide concentration and (b) carrier volume of application with different nozzles. Carrier volumes in-row (IR) are less than between row (BR) for single boom ZHA, so coverage will vary in these two row positions. This should not reduce weed control efficacy with PRE soil-residual herbicides. POST translocated herbicides should perform better than POST contract herbicides with single boom ZHA (e.g., glyphosate versus glufosinate) (i.e., less dependence on spray carrier volume and coverage for good efficacy), but this remains to be researched.

Research objectives:
The objectives of this research are to
(1) determine whether dual boom and single boom ZHA systems perform alike with PRE soil residual herbicides (e.g., atrazine / metolachlor in corn).
(2) verify that the single boom ZHA has the same advantages over broadcast application as the dual boom ZHA.

Results:
This experiment is a repeat of one conducted at Greenley in 2003. Results for the two trials are comparable and successfully establish the objectives of the study.

Table 1. Comparison of reduced rate broadcast versus dual and single boom zone herbicide application.

Characteristics	Herbicide application systems for reduced rates		
	Broadcast application	Zone herbicide application (ZHA where IR = BR zone width)	
		Single boom ZHA (One boom, one sprayer system with different even nozzle tips alternating along the boom)	Dual boom ZHA (Two offset booms at the same height, two sprayer systems with the same even nozzle tips)
In-row (IR) versus between-rows (BR) herbicide rates	IR = BR Herbicide rate	IR < BR Herbicide rates	
Herbicide rate uniform across spray swath	YES	NO, herbicide rate is a "square wave" pattern across spray swath with higher rates between rows than in rows	
Herbicide rate regulated by carrier volume, in part	NO, herbicide concentration in the spray tank varied to regulate herbicide rate applied	YES, Both herbicide concentration in the spray tank and the nozzle tips varied to regulate herbicide rate applied	NO, herbicide concentration in the spray tank varied to regulate herbicide rate applied
Spray volume output per nozzle in relation to row position [Output volume controlled by nozzle, pressure & ground speed]	Spray volume equal for all nozzles on one boom IR = BR (weed spray coverage IR = BR)	Spray volume IR < BR (weed spray coverage BR > IR)	Spray volume equal for all nozzles on one boom IR = BR (weed spray coverage IR = BR)
Potential range of herbicide rates that can be applied	Wide and continuous range is possible	Wide, but discrete "stepped" range of rates is limited by the commercial availability of even nozzle tips	Wide and continuous range of IR and BR rates is possible
Sprayer modification required	NO, One herbicide concentration in one spray tank; calibrated through one type of nozzle on one boom	YES, minor modifications of boom; One herbicide concentration in one spray tank; 2 different nozzle tips for IR and BR zones which alternate with one another on one boom; new calibration procedure	YES, major modifications - add a second sprayer system; Either (1) Two herbicide concentrations in two spray tanks applied through two different spraying systems and booms OR (2) One carrier spray tank with two herbicide injection systems + two booms

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Number of separate spraying systems needed and booms per sprayer	1	1	2
IR and BR zone widths equal	Not applicable	YES	
Nozzle position over crop rows must be controlled to control IR and BR zone widths and herbicide rates	NO	YES	
Nozzle type	Flat fan spray nozzles	Even spray nozzle tips	
Number of different nozzle types per boom	1 type of nozzle tip	2 types of nozzle tips alternating with each other on boom to vary output volume, and thus herbicide rate	1 type of nozzle tip
Nozzles evenly spaced between one another on boom	YES	YES, but 2X as many nozzles as broadcast application	YES, same number and spacing as broadcast application per boom, but 2X as many nozzles used in total
Relative sprayer modification cost of ZHA compared with broadcast spraying	Not applicable	Small start up cost for modifying existing sprayers; Double number of nozzles on available boom and buy additional even nozzle tips, nozzle mountings, strainers, and hosing	Greatest start up cost of the 3 systems; Two separate spray systems OR One carrier spray tank with two separate herbicide concentrate injection systems into different booms for applying different rates of the same herbicide or different herbicides
PRE and POST herbicides	YES (POST require more research)		

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Maximum boom height for crop clearance	25" to 50", depending upon nozzle tip and angle	25" for a 40° angle nozzle tips to create an 18" zone; boom must be lower for narrower zone widths with commercially available tips	
Limitations for POST herbicide application	NO	POST herbicides limited to early crop growth < height of boom; spray period may be extended with nozzle tips < 40° angle allowing increased boom height	
Overlap of spray patterns between adjacent nozzles across boom	_	1/8-1/16 th	
Causes for application skips or errors	1) Skips between sprayer passes	1) Skips between sprayer passes; 2) Skips within a boom spray swath if boom height is not constant while spraying (more critical for ZHA than for broadcast application because of less spray pattern overlap)	
For PRE herbicides, skips can be avoided by mounting sprayer on planter	Not critical	YES, low volume output nozzles may be needed to reduce water volume carried	
For POST herbicides, skips can be prevented with stabilizer wheels or suspension systems for long booms	Not critical	YES	
Weed control efficacy of reduced rate treatments	≤ 1X rate, depends on herbicide, weed species, weed density, soil type, and climate	ZHA has greater efficacy at lower total herbicide applied per area than comparable reduced rate broadcast applications; depends on herbicide, IR and BR rates, weed species, weed density, soil type, and environment	
Weed control efficacy can be reduced by wind	NO	YES, Wind may shift IR zone off row, so that BR rates are less than required	

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Crop competition required for herbicidal weed control	YES		
Weed control efficacy reduced by drought	YES, especially if crop canopy does not close and shade weeds		
Weed control by reduced rate treatment is consistent & predictable year_to_year	YES, depends on crop, herbicide, rate, weed, weed growth stage & environment dependent		
Herbicide damage (phytotoxicity) to sprayed crop and herbicide residue carryover damaging rotational crops of broadcast application > ZHA	YES, Depends on crop, crop variety or cultivar, herbicide, rate, & environment	NO, because IR rate is decreased in ZHA, less crop damage expected compared with broadcast application; Depends on crop, crop variety or cultivar, herbicide, rate, & environment	
Reduced herbicide spray drift hazard	NO	YES, because use rate of ZHA is less compared with reduced rate broadcast application	
Reduced chance of herbicides in runoff water	NO	YES, because use rate of ZHA is less compared with reduced rate broadcast application	