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Response of Teff Grain Yields to Several Broadleaf Herbicides Applied at Three Different Growth Stages During 2009

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Introduction

Teff (*Eragrostis tef* (Zuccagni) Trotter) is a self-pollinated, annual, warm season grass that is used throughout the world as grain for human consumption and as forage for livestock. The amount of teff produced in the United States is increasing rapidly due to its popularity as an especially nutritious grain and as high quality horse hay.

Teff is an ancient grain that was believed to have been domesticated in Ethiopia between 4000 and 1000 BC. The grain is still a major component of the diet of millions of individuals from northeast Africa and Asian countries. When grown as a grain it is normally ground into flour, which is used to make injera, a flat bread eaten with every meal. Teff grain does not contain gluten and is an increasingly important dietary component for individuals who suffer from gluten intolerance or Celiac disease.

In the U.S. most of the teff production is used for forage. Over the past five years the acreage devoted to teff production has exploded, and teff is currently grown in at least 25 states across the Nation.

Although the acreage devoted to grain production in the U.S. is small, increasing demands for teff grain from African immigrants and gluten-intolerant individuals is driving the expansion of acreage for this purpose.

The U.S. Environmental Protection Agency issued a finding in mid-2009 that no broadleaf herbicides were currently labeled for use on teff (*Erogrostis tef*), as teff had been assigned to the miscellaneous crop group. Any crop in this category must be listed on a herbicide label before that product can be applied to that crop. This action resulted in a severe hardship on agricultural producers who are currently growing, or would like to grow, teff grain or forage. Teff is slow to emerge and increase in size during the first two to three weeks of growth and is not competitive with common summer annual broad leaved weeds typically found in grass or grain crops. Recognizing the need for additional information, the authors established a field trial near Fallon, Nev. that was used to determine if several common broad-leaf herbicides used to control weeds in grain and grass crops would reduce teff grain yields when applied at different growth stages. The rates selected represent the upper and lower levels of normal applications of the selected chemicals. The timing of the

herbicide applications were selected to represent applications at the optimal time (tillered), and before (emerged) and after (boot) the optimal time of application.

Methods

The herbicides were applied to an established field of “Tiffany” teff located approximately 7 miles south of Fallon, Nev. on a Stillwater slightly saline clay loam soil as described in the Fallon-Fernley Nevada Soil Survey published by the USDA NRCS. The field had been planted on June 4, 2009 and flood irrigated three times prior to the herbicide applications.

A portion of the field did not receive irrigation water during the first irrigation but was subsequently watered the second two times. The plants growing in the section of the field receiving two irrigations prior to the herbicide applications were retarded phenologically approximately two weeks as compared to plants that had received all three irrigations. The result was the field produced plants in different growth stages growing adjacent to each other.

The first application (tillered) was established in an area in the field where the plants had begun to tiller at the time of the herbicide applications. The second application (emerged) was established at the same time in an adjacent area producing plants in the two-to-four-leaf stage. The final application was applied to plants that had reached the boot stage of growth. The teff was irrigated frequently enough that water was not limited throughout the season.

The first two trials (tillered and emerged) were applied on July 10, 2009. The third trial (boot stage) was applied on Aug. 4, 2009.

All chemicals were applied using a CO2 pressurized backpack sprayer. The sprayer nozzles were Teejet XR11002 spaced 15 inches apart. The materials were applied in 15 gallons of water per acre at 40 PSI. The plots were 5 feet by 10 feet in size and all treatments were replicated three times in a complete randomized block.

Table 1 lists the environmental conditions existing at the time of the herbicide applications.

Table 1. Environmental conditions on site during herbicide applications

Application date(s)	Application time	Wind speed(mph)/direction	Air Temperature	Soil Temperature @ 4”	Soil moisture
7-10-2009	8 a.m.	0-1/N-NW	68° F	65° F	Dry
8-4-2009	9 a.m.	2 /N	80°F	64°F	Dry

Note: weeds present in the plots included:

purslane (*Portulaca oleracea* L.), Kochia (*Kochia scoparia* L. Schrad.), common mallow (*Malva neglecta* Wallr.), field bindweed (*Convolvulus arvensis* L.), lambsquarters (*Chenopodium, album* L.), redroot pigweed (*Amaranthus retroflexus* L.), and alfalfa (*Medicago sativa* L).

Table 2 lists the chemicals and rates applied in the trials and locations. After application, the plots were visually inspected weekly for signs of herbicide damage. Visual evidence of herbicide damage was not observed at any location or trial.

The active ingredient (a.i.) or acid equivalent (a.e) represents the amount of the actual chemical that was applied to each treatment. These amounts are typically lower than the amount of total herbicide product applied. They are reported to facilitate the evaluation of chemicals and amounts between different herbicide products containing the same chemicals.

Table 2. Herbicides and rates applied to “Tiffany” teff in three different phonological stages

Herbicide	Rate a.i or a.e/acre	Product rate/acre
2,4-D amine	.475 lbs	1 pt
2,4-D amine	.95 lbs	2 pt
Dicamba	.016 lbs	2 fluid oz
Dicamba	.031 lbs	4 fluid oz
2,4-D + Dicamba	.475+.016 lbs	1 pt + 1 fluid oz
2,4-D + Dicamba	.95 +.031 lbs	2 pt + 2 fluid oz
Harmony Extra S.G.	.225 oz	.45 oz
Harmony Extra S. G.	.45 oz	.9 oz
Untreated	0	0

The plots were harvested when the seed heads had matured. Seed heads were considered mature when they had turned a uniform golden/straw color. The majority of the leaves and lower stems were green when the harvest began. The trials were harvested beginning on Sept. 30, 2009 and concluded on Oct. 5, 2009.

The evaluation of the trials consisted of harvesting a 4-feet-by-9-feet area from each plot using a gas-powered hedge trimmer and cutting all plants at ground level.

Grain Yield Results

Tables 3, 4 and 5 represent grain yields by herbicide treatment for the emerged, tillered and boot growth state of herbicide application trials. Grain yields due to each treatment followed by the same letter are not significantly different from any other treatment followed by the same letter.

Grain yields were determined by hand harvesting all seed heads from each 4-feet-by-9-feet plot, and rubbing the seed heads on a common window screen above a plastic tub until all seeds had been removed from the head. The seeds were then cleaned using a Clipper® laboratory cleaner with a 28-by-28 top screen and a 50-by-50 bottom screen. All grain figures represent clean seed.

Statistical analysis of the data consisted of an ANOVA with mean separation using Tukeys HSD at the <0.05 level of significance.

Table 3. Yields of teff grain as affected by herbicide application at the emerged stage of growth

Treatment	Product rate/Acre	Clean Grain yields (lbs/acre)*
2,4-D amine	1 pt	571
2,4-D amine	2 pt	802
Dicamba	2 fluid oz	786
Dicamba	4 fluid oz	616
2,4-D + Dicamba	1 pt + 1 fluid oz	582
2,4-D + Dicamba	2 pt + 2 fluid oz	820
Harmony Extra S.G.	.45 oz	696
Harmony Extra S. G.	.9 oz	635
Untreated	0	730

* No significant difference between treatments at the <0.05 level of significance

Table 4. Yields of teff grain as affected by herbicide application at the tillered stage of growth

Treatment	Product rate/Acre	Clean Grain yields (lbs/acre)*
2,4-D amine	1 pt	771
2,4-D amine	2 pt	658
Dicamba	2 fluid oz	805
Dicamba	4 fluid oz	616
2,4-D + Dicamba	1 pt + 1 fluid oz	605
2,4-D + Dicamba	2 pt + 2 fluid oz	832
Harmony Extra S.G.	.45 oz	605
Harmony Extra S. G.	.9 oz	558
Untreated	0	885

* No significant difference between treatments at the <0.05 level of significance.

Table 5. Yields of teff grain as affected by herbicide application at the boot stage of growth

Treatment	Product rate/Acre	Clean Grain yields (lbs/acre)*
2,4-D amine	1 pt	722 abc
2,4-D amine	2 pt	468 c
Dicamba	2 fluid oz	741 abc
Dicamba	4 fluid oz	862 ab
2,4-D + Dicamba	1 pt + 1 fluid oz	745 abc
2,4-D + Dicamba	2 pt + 2 fluid oz	676 bc
Harmony Extra S.G.	.45 oz	885 a
Harmony Extra S. G.	.9 oz	763 abc
Untreated	0	896 a

* Grain yields with the same letter are not significantly different at the <0.05 level of significance.

Conclusions

Teff grain production was not significantly different than the untreated control by any herbicide or rate tested when applied during the emerged (two-to-four-leaf stage) or tillered growth stage of teff. However, when a combination of 2, 4-D + Dicamba at 2 pints + 2 fluid ounces, respectively, was applied during the boot stage of growth teff grain production was significantly reduced when compared to the untreated control and all other treatments.

The data from this trial indicates the tested herbicides were generally safe for use on teff but that applications of 2,4-D during the boot stage may be detrimental to grain production. The results are preliminary in that they represent a single trial and further trials will be necessary to validate the results over time and in different locations throughout Nevada.

Additional resources used to prepare this fact sheet.

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