EVALUATION OF DESERT BLOOM PLUS, ION OXIDE FILM IN RECLAMATION EFFORTS, NAVAJO MINE, NORTHWEST NEW MEXICO[1]

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Abstract: Reclamation practices at Navajo Mine involve the establishment of native vegetation on mined lands. Currently, this involves incorporation of a grass hay mulch into the soil following seeding. The mulch retards moisture loss and impedes wind erosion. Reclamation areas are characteristically irrigated for two seasons. In 1992, management of Navajo Mine became interested in finding an alternative to the use of grass hay mulch that would be readily available year to year, be of consistent quality and cost, less expensive to apply, sterile, and as good as or better than hay mulch in its ability to maintain consistent soil moisture. A commercially available chemical product, Desert Bloom Plus, manufactured by Hydra-Soil International, is a possible replacement for mulch. A study implemented in June 1993, sought to compare vegetal performance using mulch and Desert Bloom Plus(DBP) in irrigated and non-irrigated conditions. Test results indicate a significant positive response of mean total cover, mean perennial grass and mean annual forb cover to irrigation. There were no differences comparing DBP, Mulch, and DBP-Mulch in either irrigated or non-irrigated treatments. Mean total cover and annual forb cover values of DBP-Mulch treatments tend to be slightly higher than mean total cover and annual forb cover values of Mulch treatments in irrigated and non-irrigated treatments.

Additional Key Words: Semi-arid Mine Land Reclamation; Mulch; Desert Bloom Plus.

Introduction

Establishment of native plants on reclaimed lands at Navajo Mine is dependant on maintenance of adequate soil moisture levels through the use of irrigation and mulch. Current practice is to crimp a grass hay mulch into the topdressing (replaced topsoil) following seeding. The mulch, when properly applied, retards moisture loss from the soil and helps prevent wind erosion. Drawbacks to using a grass mulch include: 1) availability, 2) quality, 3) fluctuating cost, and 4) weed seed. In 1992, management of Navajo Mine became interested in finding an alternative to mulch that would be readily available year to year, be of consistent quality and cost, less expensive to apply, sterile, and as good or better than mulch in its ability to maintain consistent soil moisture without increasing salt levels in the soil.

A commercially available product, Desert Bloom Plus manufactured by Hydra-Soil International was being marketed by Quattro Environmental Inc. as a mulch substitute. This was based on the ability of the chemical to form a semi-permeable membrane in association with soil particles. The membrane effectively retards moisture loss through evaporation, but does not impede gasses or liquid water movement. The composition of this product is given in Table 1.

Initial testing of the product by Navajo Mine in 1992 was not conclusive. A second study was implemented in 1993 to compare vegetal performance using mulch and Desert Bloom Plus in irrigated and non-irrigated conditions. The following report documents the development of the study and the first year of vegetal response.

Methods

A 6.1 acre block of land within the J93 reclamation area of Navajo Mine was designated for the purpose of evaluating Desert Bloom Plus(DBP) as a suitable alternative to mulch, which is currently used in the establishment of native vegetation on reclaimed lands at Navajo Mine (Figure 1). The study was planned as a 3X2 factorial design with four replications. Restricted irrigation line placement options however prevented randomization within the block. Treatment areas were established by dividing the block into seven 18.9m x 219.5m plots. Each of the plots represents one of the following treatment combinations: 1) DBP-Irrigation (DI), 2) Mulch-Irrigation (MI), 3) DBP-Mulch-Irrigation (DMI), 4) Irrigation (IRR), 5) DBP-Non-irrigation (DNI)6) Mulch-Non-irrigation (MNI), 7) DBP-Mulch-Non-irrigation (DMNI). Plots were further divided to four, 18.9m x 55m, replications. Treatment combination groups were subjected to Analysis of Variance (ANOVA) and means compared using Least Significant Difference (LSD).

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Table 1: Chemical composition of Desert Bloom Plus, Ion Oxide Film[3]

Hydrous Oxides Organic 89 %	Sulfer 2.0 %
Nitrogen Organic Based 3.0 % minimum	Innert Clays 4.0 %
Iron as Ferric Oxides 2 %	

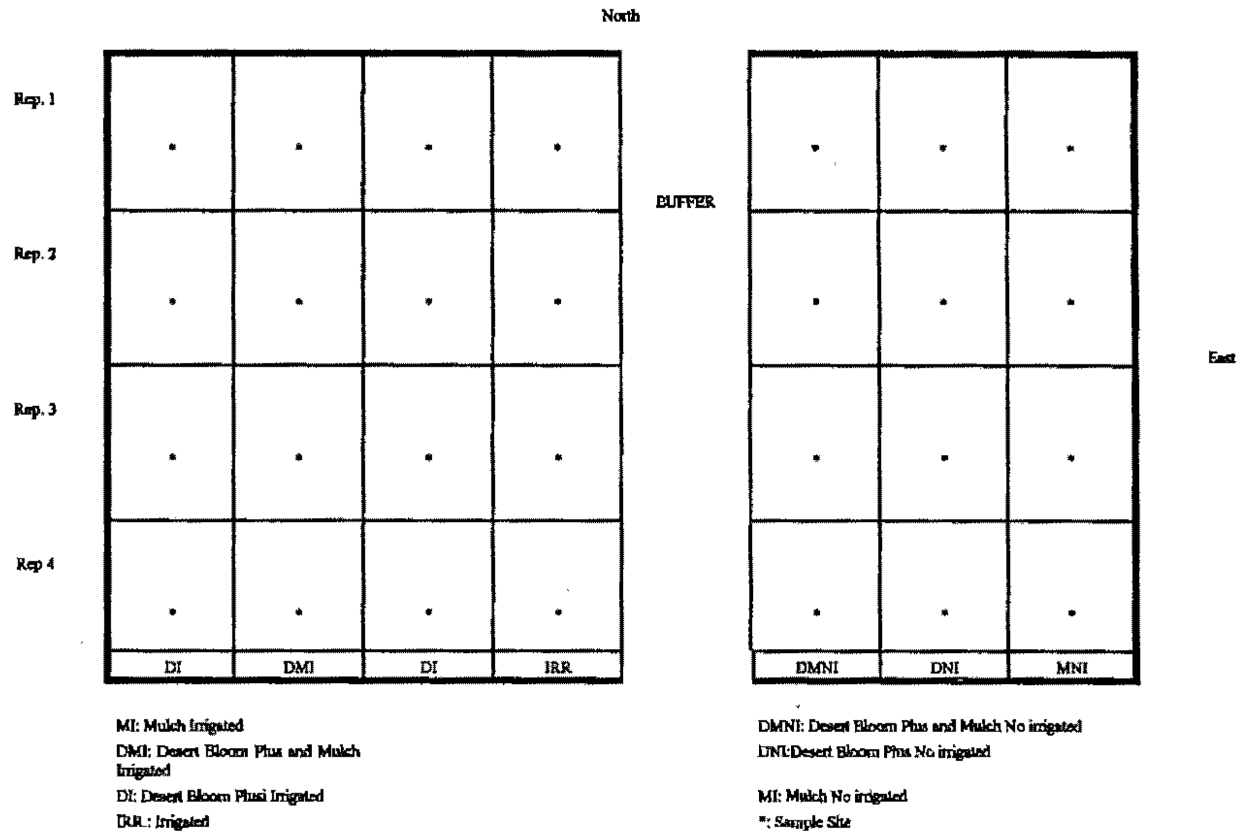

Figure 1. Desert Bloom Plus research plot plan, located in the Dodge Ramp 3, J93 reclamation area of Navajo Mine. the plot area is 6.1 acres. Each treatment area measures 18.9 by 219.5 Meters. Each replication measures 18.9 by 55 Meters.

Beginning June 8, 1993, the entire block was disced to a depth of ten inches and roller harrowed. Desert Bloom Plus was then surface applied to appropriate treatment areas with a tractor mounted boom-sprayer calibrated to a rate of 3.0 gallons DBP per acre. The DBP treatments were again disced to a depth of ten inches and roller harrowed. Prior to planting, ammonium nitrate and triple phosphate fertilizers were each applied to the block with a fertilizer spreader calibrated to 150 lbs. of fertilizer per acre.

Seeding of 17 native plant species was accomplished June 10, 1993 through June 12, 1993, using two seeding methods. Seed that had been combined into a broadcast seed mixture was surface applied over the entire block with a fertilizer broadcaster calibrated to a rate of 2.20 lbs. seed per acre. Seed that had been combined into either a large smooth seed mix or a fluffy seed mix was drilled into the soil over the entire block with a rangeland seed drill. The drill was calibrated to a rate of 1.60 lbs. seed per acre for the fluffy seed mix, and 9.13 lbs. seed per acre for the large smooth seed mix. Approximately 2¼ tons/acre of straw hay mulch was placed on the appropriate treatment areas and crimped to a depth of four inches. The seeded areas not mulched were chain dragged to insure seed incorporation. Following seeding, aluminum irrigation pipe and sprinklers

[3]Hydra-Soil International, March 1992, Composition of Desert Bloom Advisory Letter. Hydra-Soil International, Kingfisher, Oklahoma 73750.

were placed systematically over the irrigation treatments in preparation for irrigation. Placement was in a manner that would insure uniform application of water to each treatment area.

Permanent 1m x 1m sample sites were located in the center of each of the replications for each treatment. The corner of the sites were marked with ½" x 18" rebar driven partway into the ground. Water catchment containers constructed from aluminum carbonated beverage cans were attached to each of the four rebar corner markers for the purpose of documenting the amount of irrigation water at each site.

Soil Documentation

Topdressing (replaced topsoil) and spoil (rooting zone material) were sampled at sample sites for irrigated treatments on June 24, 1993, and June 25, 1993, for non-irrigated treatments from August 5 through August 11, 1993, and for all treatments, November 18, 1993. The June and August sampling consisted of digging a pit with a shovel though the topdressing and up to 12 inches into the suitable spoil. Sample pits were located immediately south of the sample site. Samples representing the top and bottom halves of the topdressing and the spoil were removed from the wall of the pit. Prior to bagging, samples were sieved to remove material larger than one inch diameter. Samples were analyzed at InterMountain Laboratories (IML) for pH, electrical conductivity (EC), saturation percentage, calcium, magnesium, sodium, sodium adsorption ratio (SAR) and textural class with percent sand, silt and clay.

Soil sampling in November was accomplished with a Giddings soil probe mechanically pushed though the topdressing and up to 12 inches into the spoil. Samples representing the top and bottom halves of the total topdressing depth and the spoil were removed from the probes collection chamber. Samples were bagged and analyzed at IML as before.

Irrigation Documentation

Water was applied to the irrigation treatments by sprinkler irrigation beginning July 2, 1993 and continuing through October 6, 1993. Determination of the amount of water applied and that occurring as precipitation at each sample site, was accomplished by measuring the amount of water occurring in each of four catchment containers at each site, and calculating an average.

Topdressing percent moisture was determined at varying time intervals through the irrigation period at each irrigation treatment sample site. Sampling at each site was accomplished by pushing a small, handheld soil probe though the topdressing at a location along each of the four sample site edges. Each soil core was divided in half, the four top halves were combined in a plastic jar, labeled and sealed. Bottom halves were treated in a similar manner. Each sample was weighed, oven dried (105°C), re-weighed, and percent moisture calculated from the difference in the weights.

Vegetation Documentation

Evaluation of vegetal response for each treatment was accomplished November 9 and 11, 1993 and July 8 and 11, 1994. Two, five meter transects were established at each sample site. The southeast and southwest corners of the one meter square sample site were used as beginning points and transects extended five meters in either an east or west direction. The end points were permanently marked with aluminum tent stakes and vegetal cover was measured using the line intercept method. Percent cover of each species was calculated as the total distance of the current years growth intercepting the five meter line.

Results and Discussion

Soil documentation 1993

The Office of Surface Mining and Reclamation (OSMRE) topdressing suitability guidelines for Navajo Mine establishes suitability ranges for various topdressing parameters including electrical conductivity (EC) and sodium adsorption ratio (SAR). The suitability range for EC is from 0 through 12 and for SAR, sandy loam and coarser soils 0 through 18. Treatment means for pre-irrigation and post-irrigation topdressing EC and SAR values were compared using analysis of variance (Tables 2 and 3). Treatment means were not calculated for suitable spoil EC and SAR values and are not presented.

Pre-irrigation:

Laboratory analysis of topdressing material removed from the irrigated treatments prior to irrigation and from the no irrigation treatments revealed that soil texture was dominantly loamy sand. The EC and SAR values for the top half and bottom half samples representing each sample site were added and mean EC and SAR values obtained. Mean EC values ranged from 0.80 to 6.41 (Table 2). These values are within suitability limits established by OSMRE. Mean SAR values ranged form 3.48 to 33.7, with seven values unsuitable based on OSMRE guidelines. Analysis of variance revealed no significant differences between treatment means for soil parameters EC and SAR (Table 2). This indicates that the topdressing prior to irrigation was uniform across the block and that any subsequent change might be due to treatment effects.

Table 2. **Comparison of treatment means for electrical conductivity (EC) and sodium adsorption ratio (SAR) values of topdressing removed from the Desert Bloom test plot of the J93 reclamation area, Navajo Mine, prior to irrigation, June 1993.**

EC Treatment	1	2	3	4	Mean
MI	0.87	3.08	2.53	0.86	1.84
DMI	1.81	1.81	6.41	0.85	2.72
DI	1.23	1.14	0.91	6.32	2.40
Irr	0.98	1.18	1.13	4.13	1.86
DMNI	0.80	0.89	1.45	4.94	2.02
DNI	1.23	1.73	2.48	3.23	2.17
MNI	0.81	0.87	1.94	3.54	1.79

Analysis of variance (ANOVA) F=0.18, P=0.98, Alpha=0.05.

SAR	Replication				
Treatment	1	2	3	4	Mean
MI	5.11	6.65	20.20	4.17	9.03
DMI	7.35	6.09	18.70	6.04	9.54
DI	18.30	6.57	4.11	22.40	12.80
Irr	3.48	4.43	6.62	13.90	7.11
DMNI	7.80	6.24	15.20	33.70	15.70
DNI	7.40	8.21	18.20	24.10	14.50
MNI	6.44	5.09	14.50	20.00	11.50

ANOVA: F=0.86, P=0.54, Alpha=0.05.

Table 3. **Comparison of treatment means for electrical conductivity (EC) and Sodium Adsorption Ratio (SAR) values of topdressing removed from the Desert Bloom Plus(D) testplot of the J93 reclamation area, Navajo Mine, post irrigation, November, 1993.**

EC	Replication				
Treatment	1	2	3	4	Mean
MI	1.72	3.15	1.64	2.48	2.25
DMI	2.06	1.19	1.63	2.27	1.79
DI	1.26	1.01	0.92	4.55	1.94
Irr	1.91	1.22	0.53	2.44	1.53
DMNI	0.78	1.07	2.61	9.53	3.50
DNI	0.56	1.26	2.24	1.58	1.41
MNI	0.91	0.88	1.02	2.34	1.29

Analysis of variance (ANOVA) F=0.99, P=0.46, Alpha=0.05.

Table 3. Continued.

SAR Treatment	Replication 1	2	3	4	Mean
MI	6.29	4.52	13.40	5.69	7.48
DMI	6.02	5.11	7.71	9.76	7.15
DI	10.49	4.41	4.09	17.30	9.07
Irr	4.86	4.77	2.42	12.50	6.14
DMNI	6.26	4.14	9.17	32.70	13.10
DNI	4.25	6.38	8.53	15.90	8.77
MNI	7.52	4.95	12.30	16.60	10.34

ANOVA: F=1.34, P=0.29, Alpha=0.05.

Post-irrigation:

Post irrigation topdressing material removed from irrigated and no irrigation treatments, was analyzed as before. Results revealed that mean EC values ranged from 0.53 to 9.53 (Table 3). These values are within suitability limits established by OSMRE. Mean SAR values ranged from 2.42 to 32.7, with two values unsuitable based on OSMRE guidelines. Analysis of variance revealed no significant differences between treatment means for the soil parameters EC and SAR (Table 3). This indicates that the topdressing was uniform across the block and that treatment effects did not significantly alter soil parameters EC and SAR.

Irrigation Documentation

Beginning July 2, 1993 through October 8, 1993, water was applied to irrigation treatments by sprinkler irrigation a total of eighteen times. Approximately one-half acre inch (mean = 0.45") of water was applied at each irrigation. Irrigation amounts were determined by measuring the amount of water in each of four water catchment containers placed at each sample site and an average of the four measurements calculated.

Soil moisture levels were determined for topdressing material at each sample site for irrigation treatments on September 9, 1993. This date was selected to represent maximum dry-down of topdressing following the August 28, 1993 irrigation application. Topdressing material was removed using a small diameter soil coring device, the total length of the core measured and divided in half. The top half and bottom half cores were kept separate to determine soil moisture levels. Analysis of variance was utilized to determine treatment differences of the August 28, 1993 irrigation and the August 9, 1993 topdressing soil moisture levels (Tables 4 and 5).

Table 4. **Comparison of Desert Bloom Plus(D) test plot treatment means for irrigation applied on August 29, 1993.**

Treatment	Replication 1	2	3	4	Mean
MI	0.49	0.49	0.49	0.48	0.49
DI	0.49	0.51	0.49	0.50	0.50
DMI	0.49	0.51	0.52	0.50	0.51
1	0.50	0.49	0.48	0.48	0.49

Analysis of variance (ANOVA) F=0.2.88, P=0.10, Alpha=0.05.

Table 5 **Comparison of Desert Bloom Plus(D) test plot treatment means for topdressing soil moisture values occurring in the top half and the bottom half of the topdressing sampled on September 9, 1993.**

Topdressing (top half) Treatment	Replication 1	2	3	4	Mean
MI	2.30	2.80	0.70	2.10	2.00
DI	0.90	1.00	0.50	2.80	1.30
DMI	0.70	0.60	0.70	0.40	0.60
I	0.90	0.60	0.40	0.70	0.70

ANOVA: F=3.86, P=0.06, Alpha=0.05.

Topdressing (bottom half) Treatment	Replication 1	2	3	4	Mean
MI	4.00	4.10	1.90	3.00	3.30
DI	1.20	1.80	0.80	4.50	2.10
DMI	1.00	1.00	1.20	1.40	1.20
I	3.90	1.40	1.50	2.40	2.30

ANOVA: F=2.50, P=0.13, Alpha=0.05.

* Values represent percent moisture.

Analysis of the irrigation August 28,1993 irrigation revealed no significant differences between treatment means, F=2.88, at the alpha = 0.05 level of significance. Treatment means ranged from 0.49" to 0.51", with DMI receiving the greatest amount of water (Table 4).

Results of the soil moisture analysis for the top half of the topdressing reveal no significant differences between treatment means, F=3.86, at the alpha=0.05 level of significance (Table 5). Treatment means ranged from 0.6% (KMI) to 2.0% (MI). Results of the bottom half of the topdressing material reveal no significant differences between treatment means, F=2.50, at the alpha=0.05 level of significance. Treatment means ranged from 1.2% (DMI) to 3.3% (MI).

Analysis of irrigation data did not reveal any significant treatment effects for the August 28, 1993 irrigation application or the topdressing moisture levels twelve days following the application. Examination of treatment means for the top and bottom topdressing moisture levels do however show that the mulch treatment had the greatest mean percent moisture followed by Desert Bloom Plus. There was little difference between DMI and Irrigation for either top or bottom samples. Calculation of topdressing percent moisture for field capacity at 12" immediately following the August 28, 1993 irrigation was 11.9%. This result indicated that the topdressing material used in the study had a low water holding capacity which may in part contribute to the lack of significance between treatments.

Vegetation Response 1993 - 1994

Vegetal Response was measured using the line-intercept method to calculate percent cover values for annual forb, annual grass, perennial forb, perennial grass, total perennial cover and total vegetal cover at each sample site. Treatment mean cover values for each vegetation category were placed into one of four treatment combination groups. Combination groups were subjected to Analysis of Variance (ANOVA) and means compared using Least Significant Difference (LSD). Treatment groups were as follows: 1). **Irrigation:** Irrigation (Mulch, Desert Bloom Plus(DBP), DBP-Mulch, Irrigation) by Non-irrigation (Mulch, DBP, DBP-Mulch), 2). **Mulch:** Mulch-irrigation (MI), DBP-Mulch-irrigation (DMI), Mulch-no irrigation (MNI),DBP-Mulch-No irrigation (DMNI), 3). **DBP:** DBP-irrigation (DI), DMI, DBP-no irrigation (DNI),DMNI, and 4). **Mulch and DBP:** MI, DI, MNI, DNI.

Irrigation Group

The irrigation group analysis for both years demonstrates a strong positive vegetal response to irrigation (Table 6). Results for 1993 showed a significant positive response of total (F=24.5), perennial grass (F=10.4) and annual forb (F=15.7) cover to irrigation at the 0.01 level of significance (Table 6). Results for 1994 showed a positive response of total perennial (F=14.0) and perennial grass (F=24.6) cover at the 0.01 level of significance and perennial forb (F=5.6) and annual grass (F=4.2) cover at the 0.05 level of significance (Table 6).

Table 6. Comparison of 1993 and 1994 Desert Bloom Plus test plot irrigated and no irrigation treatment means calculated from percent vegetation cover values.

1993	Treatment				
	Irrigated	No-irrigation			
	%	%	F	P	Significance'
Total Cover	21.40	7.43	24.50	0.000004	**
Total Perennial	2.07	0.39	1.93	0.17	NS
Perennial Forb	1.09	0.25	0.51	0.48	NS
Perennial Grass	0.99	0.14	10.39	0.003	**
Annual Forb	19.00	6.57	15.72	0.0005	**
Annual Grass	0.35	0.47	0.22	0.64	NS

Significance: * - denotes alpba - 0.05 ** - denotes alpha = 0.01 level of significance

1994	Treatment				
	Irrigated	No-irrigation			
	%	%	F	P	Significance
Total Cover	2.86	3.99	2.38	0.14	NS
Total Perennial	1.10	0.35	14.04	0.0009	**
Perennial Forb	0.01	0.17	5.57	0.03	*
Perennial Grass	1.06	0.17	24.60	0.00004	**
Annual Forb	1.45	2.58	2.57	0.12	NS
Annual Grass	0.34	1.06	4.25	0.05	*

NS = not significant

% = Percent vegetation cover

Perennial grass cover increased form 1993 to 1994 with the greatest increase in the irrigation treatments. Compared to this, annual grass cover was relatively unchanged from 1993 to 1994 in the irrigated treatments, but increased in the no irrigation treatments. Annual forb and perennial forb cover decreased between 1993 and 1994 in both the irrigated and no irrigated treatments, however, the relative degree of decrease was less in the non-irrigated treatments. This resulted in annual forb and perennial forb cover values that were higher in the 1994 no irrigation treatments compared to the 1994 irrigated treatments. These results are reflected in the 1993 and 1994, Mulch, DBP and Mulch, and DBP group analysis (Tables 7 and 8).

Mulch Group

Examination of the 1993 mulch group analysis (Table 7) shows that all significant treatment mean differences based on LSD and alpha=0.5, for each vegetation category are due to irrigation effects. Annual forb cover for treatment DMI was higher than for treatment MI and similarly DMNI was higher than MNI, even though these differences were not significant. Perennial grass, annual grass and perennial forb cover was higher for treatment MI compared to DMI and higher for treatment MNI compared to DMNI, with the exception of perennial forb cover. These differences were not significant as well.

Table 7. **Comparison of 1993 Desert Bloom Plus(DBP) test plot selected treatment means calculated from percent vegetation cover values grouped by life form.**

Mulch		**Treatment**			**ANOVA**	
	MI	**DMI**	**MNI**	**DMNI**	**F, Sig**	**LSD, 0.05**
	%[1]	%	%	%		%
Total Cover	22.8a	25.0a	8.13b	9.06b	4.46, 0.05	13.80
Total Perennial	5.89	1.29	0.38	0.55	1.72, NS	5.97
Perennial Forb	4.14	0.05	0.18	0.43	0.92, NS	6.25
Perennial Grass	1.78a	1.24ab	0.21bc	0.12c	7.27, 0.01	1.07
Annual Forb	15.80	23.30	6.89	7.97	2.64, NS	15.81
Annual Grass	1.05	0.37	0.84	0.55	1.07, NS	1.05

DBP		**Treatment**			**ANOVA**	
	DI	**DMI**	**DNI**	**DMNI**	**F, Sig**	**LSD, 0.05**
	%	%	%	%		%
Total Cover	21.3a	25.0a	5.11b	9.06b	6.63, 0.01	11.61
Total Perennial	0.52a	1.29b	0.25a	0.55ab	4.27, 0.05	0.76
Perennial Forb	0.11	0.05	0.14	0.43	1.02, NS	0.49
Perennial Grass	0.41a	1.24b	0.11a	0.12a	12.83, 0.01	0.50
Annual Forb	20.8a	23.3a	4.86b	7.97b	6.53, 0.01	11.30
Annual Grass	0.00	0.37	0.01	0.55	1.41, NS	0.67

Mulch and DBP		**Treatment**			**ANOVA**	
	MI	**DI**	**MNI**	**DNI**	**F, Sig**	**LSD, 0.05**
	%	%	%	%		%
Total Cover	22.8a	21.3a	8.13b	5.11b	12.03, 0.01	9.56
Total Perennial	5.89	0.52	0.38	0.25	2.05, NS	5.94
Perennial Forb	4.14	0.11	0.18	0.14	0.98, NS	6.25
Perennial Grass	1.78a	0.41b	0.21b	0.11b	7.33, 0.01	0.98
Annual Forb	15.8ab	20.8a	6.89b	4.86b	4.44, 0.05	12.63
Annual Grass	1.05a	0b	0.84a	0.01b	5.71, 0.05	0.81

1 - % represent mean percent vegetation cover.

2 - Means followed by the same letter are not significantly different at alpha = 0.05.

NS = Not significant

The mulch group analysis for 1994 vegetal cover categories (Table 8) does not show any significant differences that are due to other than irrigation effects. Annual forb cover and annual grass cover was higher for mulch treatments than for DBP plus Mulch treatments, though not significant. Perennial forb cover was higher for DBP plus Mulch treatments than for Mulch treatments, even though not significant. Perennial grass cover was higher in the MI treatments compared to the DMI treatment and higher in the DMNI treatment compared to the MNI treatment. These differences were not significant.

Table 8. **Comparison of 1994 Desert Bloom Plus(DBP) test plot selected treatment means calculated from percent vegetation cover values grouped by life form.**

Mulch	Treatment				ANOVA		
	MI	DMI	MNI	DMNI	F,	Sig	LSD, 0.05
	%[1]	%	%	%			%
Total Cover	2.69	1.89	3.86	3.00	0.62,	NS	11.30
Total Perennial	1.40 a 2	1.05a	0.23b	0.42b	5.22,	0.05	0.72
Perennial Forb	0.00	0.03	0.15	0.28	0.9,	NS	0.38
Perennial Grass	1.40 a	1.02a	0.08b	0.14b	15.6,	0.01	0.44
Annual Forb	0.45	0.32	1.89	1.32	1.16,	NS	1.95
Annual Grass	0.85	0.52	1.75	1.26	0.93,	NS	1.66

DBP	Treatment				ANOVA		
	DMI	DI	DNI	DMNI	F,	Sig	LSD, 0.05
	%	%	%	%			%
Total Cover	1.89	3.11	5.10	3.00	1.70,	NS	3.77
Total Perennial	1.05	1.23	0.39	0.42	2.96,	NS	0.80
Perennial Forb	0.03	0.00	0.09	0.28	1.48,	NS	0.32
Perennial Grass	1.02a	1.23a	0.31b	0.14b	6.94,	0.01	0.70
Annual Forb	0.32ac	1.88ac	4.53b	1.32c	4.96,	0.05	2.53
Annual Grass	0.52	0.00	0.18	1.26	1.27,	NS	1.58

Mulch and DBP	Treatment				ANOVA		
	MI	DI	MNI	DNI	F,	Sig	LSD, 0.05
	%	%	%	%			%
Total Cover	2.69	3.11	3.86	5.10	1.98,	NS	2.17
Total Perennial	1.40a	1.23a	0.23b	0.39b	12.5,	0.01	0.69
Perennial Forb	0.00	0.00	0.15	0.09	0.98,	NS	0.24
Perennial Grass	1.40a	1.23a	0.08b	0.31b	13.6,	0.01	0.61
Annual Forb	0.45a	1.88a	1.89a	4.53b	5.46,	0.05	1.96
Annual Grass	0.85a	0b	1.75c	0.18d	13.9,	0.01	0.64

1 - % represents mean percent vegetation cover.

2 - Means followed by the same letter are not significantly different at alpha = 0.05.

NS = Not significant

Desert Bloom Plus Group

Results of the Desert Bloom Plus group analysis for 1993 revealed several significant differences not due to irrigation effects, Table 7. Perennial grass cover was significantly higher (F=12.83, LSD=0.5%) for the DMI treatment (DMI=1.24%) than the DI treatment (DI=0.41%) Total perennial cover was significantly higher (F=4.27, LSD=0.76%) for the DMI treatment (DMI=1.29%) than the DI treatment (DI=0.52%). Annual forb cover for treatment DMI was higher than DI and DMNI higher than DNI, even though these differences were not significant. DBP-mulch treatments were higher than DBP treatments in both irrigated and no irrigation situations for perennial forb, perennial grass and annual grass. These differences as well were not significant.

Irrigation effects accounted for the majority of significant differences shown by the DBP group analysis for 1994 (Table 8). Annual forb cover for DNI (DNI=4.53%) was significantly higher (F=4.96%, LSD=2.53%) than DMNI (DMNI=1.32%). A similar result was seen when comparing DI to DMI, but was not significantly different. Annual grass cover and perennial forb cover was higher in theDBP plus Mulch treatments than the DBP treatments. Perennial grass cover was higher in DBP treatments compared to the DBP plus Mulch treatments, even though not significant.

Mulch and Desert Bloom Plus Group

Irrigation effects accounted for the predominant significant differences of the Mulch and DBP group analysis for 1993 (Table 7). Perennial grass cover was significantly higher (F=7.33, LSD=0.98%) for MI (MI=1.78%) than for DI (DI=0.41%). Annual grass cover for treatment MI (MI=1.05%) was significantly higher (F=5.71, LSD=0.81%) than for DI (DI=0.0%) and MNI (MNI=0.84%) and DNI (DNI=0.01%). Annual forb cover was highest in the irrigated treatment DI and no irrigation treatment MNI even though these differences were not significant. Perennial forb cover was higher in mulch treatments in both irrigated and no irrigation situations than in DBP treatments.

Analysis of the Mulch and DBP group in 1994 showed significant differences in annual forb cover and annual grass cover that were not due to irrigation effects (Table 8). Annual forb cover for DNI (DNI=4.53%) was significantly higher (F=5.46, LSD=1.96%) than MNI (MNI=1.89%) and annual grass cover for MI (MI=0.85%) was significantly greater (F=13.9%, LSD=0.64%) than DI (DI=0.0%). Annual forb cover for treatment DI was greater than for treatment MI, but not significant. Annual grass cover for Mulch treatments was greater tan for DBP treatments but not significant. Perennial forb cover was greater but not significant for treatment DI compared to treatment MI and greater for MNI compared to DNI. Perennial grass cover was greater, but not significant for treatment MI compared to DI and treatment DNI greater compared to treatment MNI.

Analysis of vegetal response in 1993 and 1994 did not demonstrate any significant differences that were due to the use of Desert Bloom Plus, in irrigated and no irrigated situations. Several observations are however noteworthy. In 1993, annual forb cover for treatments DI and DMI were higher than MI. In contrast to this MNI and DMNI were higher than DI. This would indicate that Desert Bloom Plus under irrigated conditions enhances annual forbs. In 1994, there was a noticeable reduction in annual forb cover for all treatments that had received irrigation in 1993. The reduction was not as noticeable however in the no irrigation treatments, especially treatment DI. If Desert Green Plus acts as an organic fertilizer, nutrients would have been mostly utilized within the irrigation treatments in 1993 and therefore not present in 1994. This would account for the noticeable drop in annual forb cover. In contrast, the nutrients in non irrigated treatments would not have been utilized to such a large degree, accounting for the less noticeable drop in cover. These results are mirrored in the total cover values for 1993 and 1994. Annual grass and perennial cover however, appears to be enhanced by MI, DMI, MNI, and DMNI. This result may be in part due to less competition with annual forbs and in part the higher percent topdressing moisture present in the Mulch irrigated treatments.

Conclusion

It may be concluded that Desert Bloom Plus did not prove to be a suitable alternative to the current use of mulch in seeding practices at Navajo Mine. As well, Desert Bloom Plus does not appear to significantly affect soil moisture levels in topdressing that is predominately sandy loam to sand, even though it is better than not using anything. It is possible that Desert Bloom Plus may act as an organic fertilizer, but this conclusion should be reserved for studies designed to demonstrate this effect.