INFLUENCE OF CULTURAL FACTORS ON ANNUAL BLUEGRASS/CREEPING BENTGRASS INTERFERENCE

ABSTRACT

Research was conducted to determine the effect of five management factors and their interactions on the species composition of a mixed stand of annual bluegrass (*Poa annua* var. *reptans* (Hausskn.) Timm.) and creeping bentgrass (*Agrostis palustris* Huds.). Soil type was an Owosso-Marlette sandy loam complex (fine-loamy, mixed, mesic, Typic Hapludalfs). Management factors investigated were irrigation (daily at 75 % open pan evaporation (OPE), triweekly at 110 % OPE, and at wilt); clipping treatments (returned or removed); nitrogen fertility (98 or 293 kg ha^{-1} yr^{-1}); plant growth regulator (PGR) treatments (mefluidide at 0.14 kg ha^{-1}, EL-500 at 1.12 kg ha^{-1} and a control) and 'Penncross' bentgrass overseeding (49 kg ha^{-1} yr^{-1} or not overseeded). Treatment design was a 3 x 2 x 2 x 3 x 2 factorial. Treatments were applied for three years. Data were collected on change in annual bluegrass populations for each year and combined over three years. Data were also collected on clipping removal effects on annual bluegrass soil seed reservoir and P and K concentrations. Returning clippings increased annual bluegrass 12% over clippings removed plots. Daily irrigation, when not-overseeded increased annual bluegrass 8% over plots overseeded with creeping bentgrass. High nitrogen fertility in combination with mefluidide increased annual bluegrass populations over 8% compared to control or EL-500 plots at the same fertility level. The greatest significant decrease in annual bluegrass (28%) was in clippings removed, overseeded, non-PGR treated plots. Clippings removed plots had 60% less viable annual bluegrass seeds and 29% less soil K than clippings returned plots.

INTRODUCTION

Annual bluegrass (*Poa annua* L.) is a major grass component in most irrigated, close-cut, golf course fairways north of the transition zone (1,28). This is especially true on creeping bentgrass (*Agrostis palustris* Huds.) fairways which are maintained at clipping heights favorable for annual bluegrass (1,2,3). Annual bluegrass is normally not desirable but is present as an invasive species. The initial invasion of annual bluegrass occurs via annual bluegrass seed present in the soil or carried in by foot traffic or machinery (3,11,15). Once established annual bluegrass can, over time, become the dominant component of the turf stand (27).

Cultural practices have been found to influence the species dominance in mixed stands containing annual bluegrass. Engel (10) found cold weather applications of nitrogen to increase annual bluegrass in creeping bentgrass. Heavy spring nitrogen applications and activated sewage sludge when compared to urea or ammonium nitrate, have been found to encourage annual bluegrass encroachment into Merion Kentucky bluegrass (*Poa pratensis* L.) (1). Mahdi and Stoutemeyer (18) found increasing rates of nitrogen to decrease the invasion of annual bluegrass into a mixed stand of 'Merion' Kentucky bluegrass and 'Common' bermudagrass (*Cynodon dactylon* L.). Eggens and Wright (9) observed that, in polystand, the competitive ability of annual bluegrass was greater than 'Penncross' creeping bentgrass, but this competitive edge decreased as the ratio of NH_4^+ to NO_3^- increased. Waddington et al. (26) found annual bluegrass invasion was favored by P and K fertilization and the effect of one was enhanced by the other. Juska and Hanson (16) reported high levels of P to reduce the efficacy of preeemergence herbicides for annual bluegrass control. In a mixed stand of annual bluegrass and creeping bentgrass Goss (14) found a P rate of 86 kg ha^{-1} significantly increased annual bluegrass invasion and sulfur fertilization at 168 kg ha^{-1} produced better bentgrass turf with less annual bluegrass.

Sprauge and Evaul (23) found higher soil moisture levels were associated with more annual bluegrass. Youngner (29) reported high, frequent irrigations which maintained high soil moisture levels favored the persistence of annual bluegrass in bermudagrass turf in southern California. Decreasing irrigation levels during periods optimal for annual bluegrass growth has been found to deter encroachment (19).

Eggens (7) found no significant increase in Kentucky bluegrass after three years of overseeding an annual bluegrass fairway. Treatment of annual bluegrass fairways with mefluidide (N-[2,4-dimethyl-5 [[(trifluoromethyl) sulfonyl] amino] phenyl] acetamide) prior to overseeding has increased the success of perennial ryegrass (*Lolium perenne* L.) overseedings (8).

Removal of clippings from a polystand of annual bluegrass and Kentucky bluegrass can significantly suppress annual bluegrass invasion when compared to clippings returned treatments (1) . Pierce et al. (18) found clipping removal to significantly increase the creeping bentgrass population in a mixed stand of annual bluegrass and creeping bentgrass.

Breuninger and Watschke (5) determined that EL-500 (α -(1-methylethyl)- α -[4-trifluoro methoxy)phenyl] 5-pyrimidine methanol) significantly decreased the annual bluegrass population in perennial ryegrass, while mefluidide suppressed seedhead production but not populations of annual bluegrass. Shoop et al. (21) reported a significant visual decrease in annual bluegrass populations in an annual bluegrass/creeping bentgrass fairway after EL-500 treatment.

The literature indicates that cultural practices play a significant role in the persistence of annual bluegrass in mixed stands. However the literature is limited on the effects of cultural practices and particularly their interactions on the species composition of mixed stands of annual bluegrass and creeping bentgrass. The objectives of this research were to evaluate the effects of five management practices and their interactions on the species composition of a mixed stand of annual bluegrass and creeping bentgrass and to evaluate the effects of clipping removal on annual bluegrass soil seed reservoir and soil and plant tissue P and K nutrient levels.

MATERIALS AND METHODS

Research was conducted at the Hancock Turfgrass Research Center, East Lansing, MI on a mixed stand of annual bluegrass and creeping bentgrass. Plot size was 1.8 x 1.2 m. Fungicides and broadleaf herbicides were applied as needed to prevent broadleaf weed invasion and disease. Treatments were initiated in May of 1984 and terminated in October of 1986. Experimental design was a randomized complete block with three replications. Treatment design was a 3 x 2 x 2 x 3 x 2 factorial with two splits, with irrigation treatments as main plots, clipping removal treatments as subplots and nitrogen fertility, PGR and overseeding factors as sub-sub plots.

CULTURAL TREATMENTS

Irrigation treatments were started the first week in June and terminated the second week in September in all years of the study. Treatments were applied via sprinkler irrigation through quarter-circle heads which delivered 20 mm hr^{-1}. Two of the treatments were based on daily evaporation readings obtained from a Class A evaporative pan located adjacent to the treatment area. These treatments were daily irrigation at 75 % of open pan evaporation (OPE) and triweekly irrigation at 110% OPE. Rainfall was subtracted from the required irrigation amount prior to application. A third treatment was applied when the plots exhibited moderate to severe wilt symptoms (i.e. footprinting and/or a blueing of the plot area). Irrigation and rainfall amounts are shown in Table 1.

Clipping treatments consisted of mowing with (clippings removed) or without (clippings returned) the catch baskets on a triplex greens mower. Mowing frequency was three times per week with a height of cut of 13 mm (bench setting). Clipping treatments were started in early May and ended in late September of each year of the study.

Table 1. Irrigation and precipitation amounts for three irrigation treatments applied to annual bluegrass/ creeping bentgrass interference study.

	IRRIGATION TREATMENT+											
	75%	110%	WLT	PPT	75%	110%	WLT	PPT	75%	110%	WLT	PPT
MONTH/YR	1984				1985				1986			
	------mm-----											
APRIL-MAY	0	0	0	171	0	0	0	164	0	0	0	143
JUNE	147	221	20	10	66	137	27	52	86	80	0	193
JULY	102	168	13	45	115	198	17	52	52	140	8	61
AUGUST	91	74	0	94	46	69	30	91	55	96	7	62
SEPT	48	28	0	77	0	33	0	93	18	0	0	208
TOTALS	388	491	33	397	227	437	74	452	211	316	15	667

+ Irrigation treaments; daily irrigation at 75% of open pan evaporation (OPE), 3 times per week at 110% of OPE and irrigation at wilt (WLT).

Nitrogen fertility treatments were 98 kg ha^{-1} yr^{-1} (low-N) and 293 kg ha^{-1} yr^{-1} (high-N) applied as urea (46-0-0). High-N treatments were applied monthly on the 15th of May through September and November at 49 kg ha^{-1} per application. Low-N treatments were applied the 15th of June, July, September and November at 24.5 kg ha^{-1} per application. Fertilizer carrier was urea (46-0-0).

PGR treatments consisted of mefluidide, EL-500 and a control. Mefluidide treatments were applied 15 May 1984, 30 April 1985, and 25 April 1986 at 0.14 kg ha^{-1}. Due to the late application timing in 1984 mefluidide treatments were applied with 0.5 % HA-89 surfactant. EL-500 treatments were applied 15 May 1984 at 1.68 kg ha^{-1} and 14 May 1985, and 30 April 1986 at 1.12 kg ha^{-1}. Treatments were applied with a hand held CO_2 sprayer calibrated to deliver 467 L ha^{-1} at 0.21 MPa.

In August of each year overseeding treatments were applied. The overseeding treatment was a broadcast overseeding of Penncross creeping bentgrass at 49 kg ha^{-1}. Prior to overseeding the experimental area was verticut with a triplex mower equipped with verticut reels. The verticut reels were set to a depth which cut through the turf and thatch but just lightly into the soil. Overseeding treatments were than applied and brushed in with a nylon bristle broom. Immediately after overseeding the area received 5 mm irrigation.

Data were obtained on the population of annual bluegrass in each plot. The annual bluegrass population was estimated by modification of the vertical point quadrat method described by Tinney et al. (24). A PVC frame 1.8 x 1.2 m with an internal monofilament grid of 112 intersections on 100 mm centers was placed over an individual plot. The presence of annual bluegrass under an intersection was recorded as a "hit". The number of hits per plot was divided by 112 and multiplied by 100 to obtain an estimate of the percentage annual bluegrass in each plot. The precision of this method was validated by recounts of randomly selected plots. At no time did the recounts deviate more than 5% from the original estimates. Initial population estimates were made in the spring of 1984 and yearly annual bluegrass population changes were calculated from counts obtained in the fall of 1984, 1985, and 1986. The change in annual bluegrass populations for each year and the sum of the population shift for three years were used in data analysis.

STATISTICAL ANALYSIS

To control error and increase precision in the analysis the initial annual bluegrass population estimates obtained in 1984 were used as a covariate and the experiment analyzed by analysis of covariance. Data were analyzed with SAS (Statistical Analysis System, SAS Institute Inc., Cary, NC), utilizing the General Linear Models procedure. Planned comparison of means were performed by orthogonal contrasts.

SEED RESERVOIR AND TISSUE AND SOIL P AND K CONCENTRATIONS

In November of 1985 and 1986 samples were obtained from the clipping treatments with a 91 cm^2 core sampler to a depth of 7.6 cm. In 1985 two samples per replication were obtained for each treatment (n=6). In 1986 three samples per replication were obtained for each treatment (n=9). The core samples were air-dried and broken up over a flat in the greenhouse. The flats were irrigated twice daily for four minutes with an automatic misting system. Temperature in the greenhouse fluctuated between 10° and 24° C. After 25 days the number of annual bluegrass plants in each flat were counted. Data were expressed as the number of viable annual bluegrass seeds per 100 gms soil, based on a soil bulk density of 1.5 gm cm^{-3}. Clipping treatments were compared using a Student's t test.

Clippings and soil samples were collected from the clipping treatments and analyzed for P and K. Clipping samples were obtained 6 June and 25 October, 1986. Soil samples were taken 21 June, 1985 and 27 October, 1986 to a depth of 76 mm with a 25 mm diameter soil probe. Both clipping and soil samples were digested in nitric acid and analyzed for P and K using emission spectroscopy. Treatments were separated using a Student's t test.

RESULTS AND DISCUSSION

The results of the analysis of covariance are shown in Table 2. Main effects or interactions not shown were not significant at any time in the study. Discussion of results will be confined to significant yearly and combined year main effects and significant interactions for the combined year analysis.

Table 2. Analysis of covariance. Influence of cultural practices on annual bluegrass (*Poa annua* var. *reptans*) and creeping bentgrass (*Agrostis palustris*) interference

	YEAR			
	1984	1985	1986	COMB.
MAIN EFFECTS				
CLIPPING TRTMNTS (CR)	**	NS	*	**
N-FERTILITY (F)	NS	**	NS	NS
PLANT GROWTH REG (PGR)	NS	NS	NS	*
COVARIATE-INITIAL ANNUAL BLUEGRASS POPULATION	**	NS	NS	**
INTERACTIONS				
IRRIGATION (I) x CR	**	NS	NS	NS
I x OVERSEEDING (O)	*	NS	NS	*
I x F	NS	**	NS	NS
PGR x F	NS	NS	NS	*
PGR x F x CR	NS	NS	*	NS
O x I x CR x F	NS	*	NS	NS
O x PGR x CR	NS	NS	*	*

*, **, or NS indicate significance at P = 0.05, P = 0.01 and non-significant, respectively.

After three years, clipping removal significantly decreased the annual bluegrass population when compared to plots where clippings were returned. For individual years clipping removal reduced the annual bluegrass population in 1984 and 1986 but not in 1985 (Table 3). These results concur with the findings of others (1,20). Several explanations are possible for the clipping treatment response. Fales and Wakefield (12) observed that suppression of the growth of forsythia and flowering dogwood by three turfgrasses may involve chemical inhibition. Annual bluegrass clippings may contain allelo-chemicals which selectively inhibit the growth of creeping bentgrass or enhance the growth of annual bluegrass. Brede and Harris (4) reported that annual bluegrass seeds may secrete a water insoluble toxin which significantly inhibits creeping bentgrass seedlings. High P and K levels have been shown to favor annual bluegrass (26). Removing clippings decreases specific soil nutrient levels which may favor creeping bentgrass over annual bluegrass. Finally the prolific seed production of annual bluegrass (1) and its ability to produce viable seed on excised panicles (17) coupled with seed production throughout the growing season (11) indicate that the returning of clippings may, in effect, be annual bluegrass overseeding.

Nitrogen fertility significantly affected the annual bluegrass population in only one year of the three year investigation. In 1985 plots that received 98 kg ha^{-1} yr^{-1}

had significantly less annual bluegrass than plots which received 293 kg ha^{-1} yr^{-1} (Table 3). Beard et al. (1) and Waddington et al. (26) found urea treated plots to have less annual bluegrass than plots which received activated sewage sludge. The increase in the annual bluegrass in sewage sludge treated plots was postulated to be due to the P present in the sewage sludge and absent in the urea (26). Engel (10) reported that nitrogen fertility procedures were unlikely to be the major cause of the encroachment of annual bluegrass into creeping bentgrass in New Jersey.

PGR's did not significantly affect the annual bluegrass population in any one year of the study, but when the data were combined over all three years PGR's were a significant source of variability. In the combined year analysis mefluidide treated plots had significantly more annual bluegrass than either the control or EL-500 treated plots (Table 4). Mefluidide inhibits annual bluegrass seedhead production (5,6). Spring applications of mefluidide coincide with a period when annual bluegrass seedhead production is very high (11). After mefluidide applications, the assimilates and reserves normally allocated to seedhead production may be reallocated to other portions of the plant such as roots or crown tissue. In perennial ryegrass (*Lolium perenne* L.) flower production has been found to limit the initiation of main root axes (25). Soper (22) observed an increase in the summer survival of ryegrass (*Lolium* spp.) when the ratio of

Table 3. Main effect means for clipping and N-fertility treatments averaged across all other factors. (n= 108). Means for 1984 and combined year analysis are adjusted for the covariate (initial annual bluegrass population).

	YEAR			
	1984	1985	1986	COMBINED
	---annual bluegrass population (% change)---			
Clippings				
Returned	0.7	-7.5	-3.4	-10.0
Removed	-5.3	-8.1	-8.8	-22.1
N-Fertility				
98 kg ha^{-1} yr^{-1}	-2.0	-10.1	-4.8	-16.1
293 kg ha^{-1} yr^{-1}	-2.6	-6.2	-7.5	-16.1

Table 4. Main effect means for plant growth regulator treatments averaged across all other treatments (n = 72). Means for 1984 and combined year are adjusted for the covariate (initial annual bluegrass population).

	YEAR			
	1984	1985	1986	COMBINED
	---annual bluegrass population (% change)---			
PGR Treatment				
Mefluidide	-0.5	-8.4	-5.6	-13.4
EL-500	-3.3	-8.7	-4.9	-17.4
Control	-3.2	-7.3	-7.7	-17.5

Orthogonal comparisons for combined year adjusted means

	OSL[+]
Mefluidide vs Control	0.03
Mefluidide vs EL-500	0.03
EL-500 vs Control	0.96

[+] Observed significance level

vegetative to reproductive culms increased. Cooper et al. (6) found mefluidide treated annual bluegrass to have deeper roots and greater root elongation rates than untreated annual bluegrass. The inhibition of seedhead formation by mefluidide may increase the persistence of annual bluegrass by promoting new root initiation or reducing summer root deterioration.

Plots which were not overseeded and irrigated daily at 75% of OPE had significantly more annual bluegrass than the non-overseeded plots irrigated at 110% OPE 3 times per week or at wilt (Table 5). Continuous high soil moisture levels have been observed to encourage annual bluegrass (23,29). In this study the frequency of irrigation (daily vs. triweekly or at wilt) may have influenced the dominance of annual bluegrass more than irrigation amount. Daily irrigation maintains soil moisture levels in the upper regions of the soil profile at levels which may favor the existing annual bluegrass plants or germination of new plants from annual bluegrass seed present in the soil. Table 5 also shows that for bentgrass overseeding to be effective plots must be irrigated daily.

The response of mefluidide was significantly affected by N-fertility while the EL-500 and control treated plots were unaffected (Table 6). High N-fertility in combination with mefluidide increased annual bluegrass populations.

Table 7 displays the data for the PGR X Clipping Removal X Overseeding interaction for the combined year

Table 5. Irrigation x Overseeding interaction means for combined year analysis. Means are adjusted for covariate (initial annual bluegrass population).

	IRRIGATION TREATMENT+		
	75%	110%	WILT
	---annual bluegrass population (% change)---		
Overseeded++	-17.5	-14.1	-20.8
Non-Overseeded	-9.7	-15.6	-18.7

Orthogonal comparisons

	OSL+++
Non-Overseeded:	
75% vs 110%	0.03
75% vs WILT	<0.01
Overseeded vs Non-Overseeded:	
at 75%	<0.01
at 110%	0.56
at WILT	0.42

+ Irrigation treatments were: daily irrigation at 75% of open pan evaporation (OPE), 3 times per week at 110% of OPE and irrigation at wilt.

++ Plots were overseeded in mid-August with Penncross creeping bentgrass at 49 kg ha^{-1}

+++ Observed significance level

Table 6. Plant Growth Regulator x N-Fertility interaction means for combined year analysis.

Plant Growth Regulator	N-Fertility (kg ha^{-1} yr^{-1}) 98	293
	---annual bluegrass population (% change)---	
Mefluidide	-16.2	-10.6
EL-500	-15.4	-19.4
Control	-16.7	-18.3

Orthogonal comparisons:

	OSL+
Control:Low N vs High N	0.54
Mefluidide:Low N vs High N	0.04
EL-500:Low N vs High N	0.13
High N:	
Mefluidide vs Control	<0.01
Mefluidide vs EL-500	<0.01
EL-500 vs Control	0.67
Low N:	
Mefluidide vs Control	0.84
Mefluidide vs EL-500	0.76
EL-500 vs Control	0.62

+ Observed Significance Level

Table 7. Overseeding x Plant Growth Regulator x Clipping Treatment interaction means for combined year analysis. Means are adjusted for covariate (initial annual bluegrass population). Data represent % change in annual bluegrass populations.

	Plant Growth Regulator Treatment					
	Mefluidide		EL-500		Control	
Clipping Treatment+	C+	C-	C+	C-	C+	C-
Overseeding Treatment++	--annual bluegrass population (% change)--					
OS	-10.1	-20.5	-14.4	-23.3	-8.2	-28.4
Non-OS	-9.6	-13.3	-6.8	-25.1	-11.1	-22.2

<u>Orthogonal comparisons:</u>

	OSL+++	
Mefluidide: OS(C-) vs OS(C+)	<0.01	
Control:		
OS(C-) vs OS(C+)	<0.01	
Non-OS(C-) vs Non-OS(C+)	<0.01	
EL-500:		
OS(C-) vs OS(C+)	0.02	
Non-OS(C-) vs Non-OS(C+)	<0.01	
OS(C+) vs Non-OS(C+)	0.04	
	OS	Non-OS
Clippings Returned:		
Control vs EL-500	0.09	0.25
Control vs Mefluidide	0.39	0.67
Mefluidide vs EL-500	0.24	0.46
Clippings Removed:		
Control vs EL-500	0.18	0.44
Control vs Mefluidide	0.04	0.02
Mefluidide vs EL-500	0.47	<0.01

\+ C+ and C- designate clippings returned and clippings removed, respectively.

++ Overseeding treatments were overseeded (OS) in mid-August with Penncross creeping bentgrass at 49 kg ha^{-1} or not overseeded (Non-OS).

+++ Observed Significance Level

analysis. Within the control and EL-500 plots the clippings removed treatment, overseeded or not, had significantly less annual bluegrass than the corresponding clippings returned plots. However, the mefluidide plots exhibited the same clipping effect only when overseeded. Within the EL-500 clippings returned treatments, the overseeded plots had less annual bluegrass than the non-overseeded plots. The application of EL-500 may have suppressed the spring growth of the polystand enough to allow successful establishment of bentgrass from seed, or suppressed the spring germination of annual bluegrass seed present in the soil. EL-500 has been shown to exhibit preeemergence activity on both annual bluegrass and creeping bentgrass (13), when applied at time of seeding. Within the overseeded plots PGR applications had no effect in the clippings returned plots, but in the clippings removed plots the mefluidide treatments had significantly more annual bluegrass than the control plots. This was also true of the non-overseeded plots. The non-overseeded, clippings removed plots treated with EL-500 also contained less annual bluegrass than the corresponding mefluidide treated plots but did not differ from the corresponding control plots.

SEED RESERVOIR AND TISSUE AND SOIL P AND K CONCENTRATIONS

Clipping returned plots had significantly more viable annual bluegrass seeds than the clippings removed plots. In 1985 clippings returned plots had 42 viable annual bluegrass seeds per 100 gms of soil vs. 16 seeds per 100 gms for the clippings removed plots. In 1986 clipping returned plots contained 13 seeds per 100 gms of soil vs. 5 seeds per 100 gms of soil for the clipping removed plots. Although the amount of viable annual bluegrass seeds in the clipping removed plots is quite high, when averaged across years, these plots contained 60% less annual bluegrass seeds than the clippings returned plots. The difference between the two treatments should increase the establishment of annual bluegrass plants from seed in the clippings returned treatment. The data supports the hypothesis that the returning of clippings is a passive form of annual bluegrass overseeding.

Clipping removal significantly lowered the soil K levels when compared to clippings returned plots (Table 8). The K levels in tissue samples were also reduced by clipping removal on the 6 June, 1986 sampling date, but not on the samples obtained in October. Waddington et al. (26) found high K

Table 8. Clipping removal effects on tissue and soil P and K concentrations of an annual bluegrass creeping bentgrass polystand.

	Element							
	P	K	P	K	P	K	P	K
	Sample Date							
	6/6/86		10/25/86		6/21/85		10/27/86	
Clipping Treatment	Tissue				Soil			
	-----mg kg^{-1}----				-----kg ha^{-1}----			
Removed	488a	2451a	477a	1063a	133a	96a	74a	87a
Returned	509a	2751b	493a	1100a	129a	145b	75a	113b

Numbers within columns followed by different letters are significantly different based on a paired t test (P=0.05) levels to enhance the encroachment of annual bluegrass into creeping bentgrass. The reduction of K concentrations in the clipping removed plots may have been a factor in the reduction of annual bluegrass populations in the clipping removal plots. P levels in both the soil and tissue samples were unaffected by clipping removal.

The results of this investigation indicate that cultural practices can play a significant role in enhancing or detering the encroachment of annual bluegrass in close-cut creeping bentgrass. Clipping removal reduced the encroachment of annual bluegrass into creeping bentgrass and also reduced the reservoir of annual bluegrass seed in the soil and soil and plant tissue K concentrations. High N fertility increased annual bluegrass in one year of the study but did not prove to be a significant factor over time. Treatment with mefluidide, singly or in combination with high N fertility increased annual bluegrass populations. Overseeding was effective in increasing creeping bentgrass only when plots were treated with EL-500 or irrigated daily. However, daily irrigation without overseeding increased annual bluegrass. The numerous interactions observed indicate that the persistence of annual bluegrass can not be easily isolated to any one management practice but depends on the overall cultural program.

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