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Standardization of seed rates for turf establishment under mid hill conditions

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ABSTRACT

The present investigations were carried out at the experimental farm of Department of Floriculture and Landscape Architecture, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, (HP) during 2020-21. The experiment was laid out in a randomized block design with three replications. Experiment consisted of four genotype(s) of lawn grasses including *'Lolium perenne'*, *'Agrostis stolonifera'*, *"Festuca rubra"* and *"Cynodon dactylon"* with five different seed rates for quality turf establishment. Amongst the different seed rates used, standard seed rate (S_1) and 5% increased seed rate (S_2) performed well in all the genotypes used with respect to days taken for turf establishment, total weed count, visual texture, compactness, diseases incidence and appearance. The most presentable lawn with early turf establishment, low weed count, lesser number of mowing required, consistent turf colour, fine leaf texture, compactness, less diseases incidence and overall appearance was observed in *'Agrostis stolonifera'*, when sown with a standard seed rate of 8.00 g/m^2 followed by *'Lolium perenne'* sown with a standard seed rate of 38.00 g/m^2.

Key words: Seed rate, turf establishment, mowing frequency, chlorophyll content, turf cover.

INTRODUCTION

Development, production and management of particularly specialized grasses for utility, aesthetics and recreation, make up the turf grass industry which is an important part of floriculture industry. It involves science, creational development and the sale of turfgrass product and services. Use of lawn grasses as a tool to create a soft and dreamy effect in the surrounding has been in use since last fifty years. Lawn is now being considered as an intrinsic part of a garden which provides an open landscape and aesthetic beauty to the surroundings (Sindhu, 12). Scientific reports say that lawn grasses have ability to mitigate run-off especially from concrete jungles, absorb atmospheric pollutants, save energy owing to the evaporative cooling effect it provides, remediate contaminated soils, increase property values and enhance mental health (Tiwari *et al*., 14). Many outdoor sports, recreational and leisure activities, which are source of enjoyment and of benefits to physical health of modern man, utilize turf (Beard and Green, 2).

Methods of establishing a lawn differ depending on the characteristics of the species or the cultivar involved and also on the availability of the planting material. Easy transportation of planting material and quick germination makes seeding the cheapest and uniform method of establishment for large areas. Growth habit and seed size are the main factors to determine the amount of seed rate to be used. Inexperienced individuals are often tempted to use too much seed which not only wastes money but also results in excess competition and delayed establishment (Christians, 3). The seed rates per unit area have been standardized by different seed companies all over the world, however, no systematic work till date has been done in India with respect to these seed rates. We, therefore, need to come up with seed rates especially for Nauni-Solan conditions, falling in the mid hill zone of the state. In the context of the present scenario, a field experiment was planned with the objectives:

i) To optimize the seed rates of cool and warm season lawn grasses.
ii) To compare the growth pattern of commercial cool and warm season lawn grasses.

MATERIALS AND METHODS

The four grass species evaluated were *'Lolium perenne'* L. (G_1), *'Agrostis stolonifera'* L. (G_2), *"Festuca rubra"* L. (G_3), *"Cynodon dactylon"*[L] Pers. (G_4). Seeds were procured from DLF Pickseed, Halsey, Oregon USA through Peak Traders, Gurgaon.

The experiment was carried out at the experimental farm of Department of Floriculture and Landscape Architecture in the year 2020-2021.

Each species was sown at five different seed rates i.e. Standard Seed Rate (S_1), 5% increased Seed Rate (S_2), 5% reduced Seed Rate (S_3), 10% reduced Seed Rate (S_4), 15% reduced Seed Rate

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(S_5). The experiment was conducted under open-field conditions in randomized block design (RBD Factorial) with three replications for each treatment combination.

Treatment Combinations: 20

G_1S_1 : *'Lolium perenne'*, Standard Seed Rate (38.00 g/m^2)
G_1S_2 : *'Lolium perenne'*, 5% increased Seed Rate (39.90 g/m^2)
G_1S_3 : *'Lolium perenne'*, 5% reduced Seed Rate (36.10 g/m^2)
G_1S_4 : *'Lolium perenne'*, 10% reduced Seed Rate (34.20 g/m^2)
G_1S_5 : *'Lolium perenne'*, 15% reduced Seed Rate (32.30 g/m^2)
G_2S_1 : *'Agrostis stolonifera'*, Standard Seed Rate (8.00 g/m^2)
G_2S_2 : *'Agrostis stolonifera'*, 5% increased Seed Rate (8.40 g/m^2)
G_2S_3 : *'Agrostis stolonifera'*, 5% reduced Seed Rate (7.60 g/m^2)
G_2S_4 : *'Agrostis stolonifera'*, 10% reduced Seed Rate (7.20 g/m^2)
G_2S_5 : *'Agrostis stolonifera'*, 15% reduced Seed Rate (6.80 g/m^2)
G_3S_1 : *"Festuca rubra"*, Standard Seed Rate (22.50 g/m^2)
G_3S_2 : *"Festuca rubra"*, 5% increased Seed Rate (23.60 g/m^2)
G_3S_3 : *'Festuca rubra'*, 5% reduced Seed Rate (21.40 g/m^2)
G_3S_4 : *'Festuca rubra'*, 10% reduced Seed Rate (20.30 g/m^2)
G_3S_5 : *'Festuca rubra'*, 15% reduced Seed Rate (19.10 g/m^2)
G_4S_1 : *'Cynodon dactylon'*, Standard Seed Rate (9.00 g/m^2)
G_4S_2 : *'Cynodon dactylon'*, 5% increased Seed Rate (9.45 g/m^2)
G_4S_3 : *'Cynodon dactylon'*, 5% reduced Seed Rate (8.55 g/m^2)
G_4S_4 : *'Cynodon dactylon'*, 10% reduced Seed Rate (8.10 g/m^2)
G_4S_5 : *'Cynodon dactylon'*, 15% reduced Seed Rate (7.65 g/m^2)

The land was dug deep to a depth of one foot. Pebbles, stones and other materials like weeds and unwanted plants were eliminated and field was leveled well. Raised beds of 1m^2 with proper drainage channels were prepared. Mixture of sand, soil and cocopeat was spread in the ratio 1:1:1. Sowing of seeds in the field was done on 17th March 2020 and was covered with 1cm layer of the media prepared. Until the seed germination was initiated the plots were covered with jute cloth and irrigated regularly to keep the media moist. After 45 days of sowing a spray of 2% urea was applied to aid the growth of seedlings. Data was collected and presented in Table 1 and 2 for Days taken for germination and turf establishment (days were counted from the date of sowing to the date when 75% seeds sprouted and from the date of sowing to the date of complete turf cover establishment respectively), mowing frequency (maintaining 3 cm culm length), total weed count (weed species were identified and number of weeds per m^2 was counted at monthly intervals) presented in Table 3, chlorophyll content presented in Table 4 (Recorded quarterly as per the method of Hiscox and Israelstam, 4), appearance score presented (Figure 1) evaluated on the basis of turf colour (colour chart of 'The Royal Horticulture Society", London), turf texture (hand feel method by Srivastava and Kumar (13), visual texture (as fine, fine to medium, medium

Table 1. Scores allotted to various parameters for evaluating appearance.

	Parameter	Description	Points allotted
1	Turf colour	Green Group-137-A,137-B, 137-C, 137-D	5
		Green Group-143-A	4
		Yellow- Green Group-147-B	3
		Orange-White Group-159-A, 159-B, 159-C	2
2	Turf texture (Hand feel method)	Fine	5
		Fine to medium	4
		Medium to coarse	3
		Coarse	2
3	Visual texture	Fine	5
		Fine to Medium	4
		Medium to coarse	3
		Coarse	2
4	Turf spread	Uniform growth throughout the area	5
		Area showing uneven growth without any patch	4
		Area showing uneven growth with patch up to 20%	3
		Area showing uneven growth with patch exceeding 20% area	2
5	Diseases and insect-pest incidence	Nil	5
		<250cm^2 (low)	4
		250-500cm^2 (medium)	3
		>500cm^2 (high)	2

Table 2. Effect of different seed rates and genotypes on days taken for germination.

	S_1	S_2	S_3	S_4	S_5	Mean
(G_1)*Lolium perenne*	7.67	8.33	8.00	8.33	8.33	8.13
(G_2)*Agrostis stolonifera*	15.67	14.67	16.00	15.67	15.33	15.47
(G_3)*Festuca rubra*	13.33	13.67	13.67	13.67	13.33	13.53
(G_4)*Cynodon dactylon*	58.33	57.33	59.00	59.33	59.67	58.73
Mean	23.75	23.50	24.17	24.25	24.17	
$CD_{0.05}$ for:	Genotype (G)= 0.63					
	Seed Rate (S) = NS					
	G × S = NS					

Table 3. Effect of different seed rates and genotypes on days taken for turf establishment.

	S_1	S_2	S_3	S_4	S_5	Mean
(G_1) *Lolium perenne*	42.67	42.33	44.33	45.67	47.00	44.40
(G_2) *Agrostis stolonifera*	60.67	58.67	61.67	62.67	64.33	61.60
(G_3) *Festuca rubra*	46.67	44.33	46.67	51.00	52.33	48.20
(G_4) *Cynodon dactylon*	96.33	95.33	98.67	99.67	102.33	98.47
Mean	61.58	60.17	62.83	64.75	66.50	
$CD_{0.05}$ for:	Genotype (G)= 0.45					
	Seed Rate (S)= 0.49					
	G × S = 0.99					

Table 4. Effect of different seed rates and genpotypes on total weed count from April, 2020 to March, 2021.

	S_1	S_2	S_3	S_4	S_5	Mean A
(G_1)*Lolium perenne*	104.50	95.67	131.67	129.00	140.17	120.20
(G_2)*Agrostis stolonifera*	81.17	69.50	86.50	86.33	101.00	84.90
(G_3)*Festuca rubra*	144.00	120.83	144.50	158.83	172.67	148.17
(G_4)*Cynodon dactylon*	110.00	86.33	116.33	125.67	135.17	114.70
Mean B	109.92	93.08	119.75	124.96	137.25	
$CD_{0.05}$ for:	Genotype (G) = 6.86					
	Seed Rate (S) = 7.67					
	G × S = NS					

to coarse and coarse (Verma, 15)), turf spread and diseases and insect-pest incidence carrying maximum of 5 points each, making the total score of 25 (Verma, 15).

RESULTS AND DISCUSSION

The fastest growing genotype was *'Lolium perenne'* (G_1) which took 8.13 days for germination while, maximum days (58.73 days) for germination were taken by *"Cynodon dactylon"* (G_4). Findings of this study are comparable to those of Zhu *et al*. (17). In the present study, maximum days taken by *"Cynodon dactylon"* (G_4) for germination were due to the lack of favourable temperature conditions at the time of sowing during March and conditions improved substantially after the month of April, 2020 (27 to 35ºC) for seeds to germinate. Similar results have been reported by Patton *et al*. (11).

Among different genotypes, *'Lolium perenne'* (G_1) took least number of days (44.40 days) for turf establishment while, maximum days (98.47 days) were taken by *"Cynodon dactylon"* (G_4). Among different seed rates, minimum number of days were taken by 5% increased seed rate (S_2). In contrast, maximum days for turf establishment were taken by 15% reduced seed rate (S_5). The interaction between

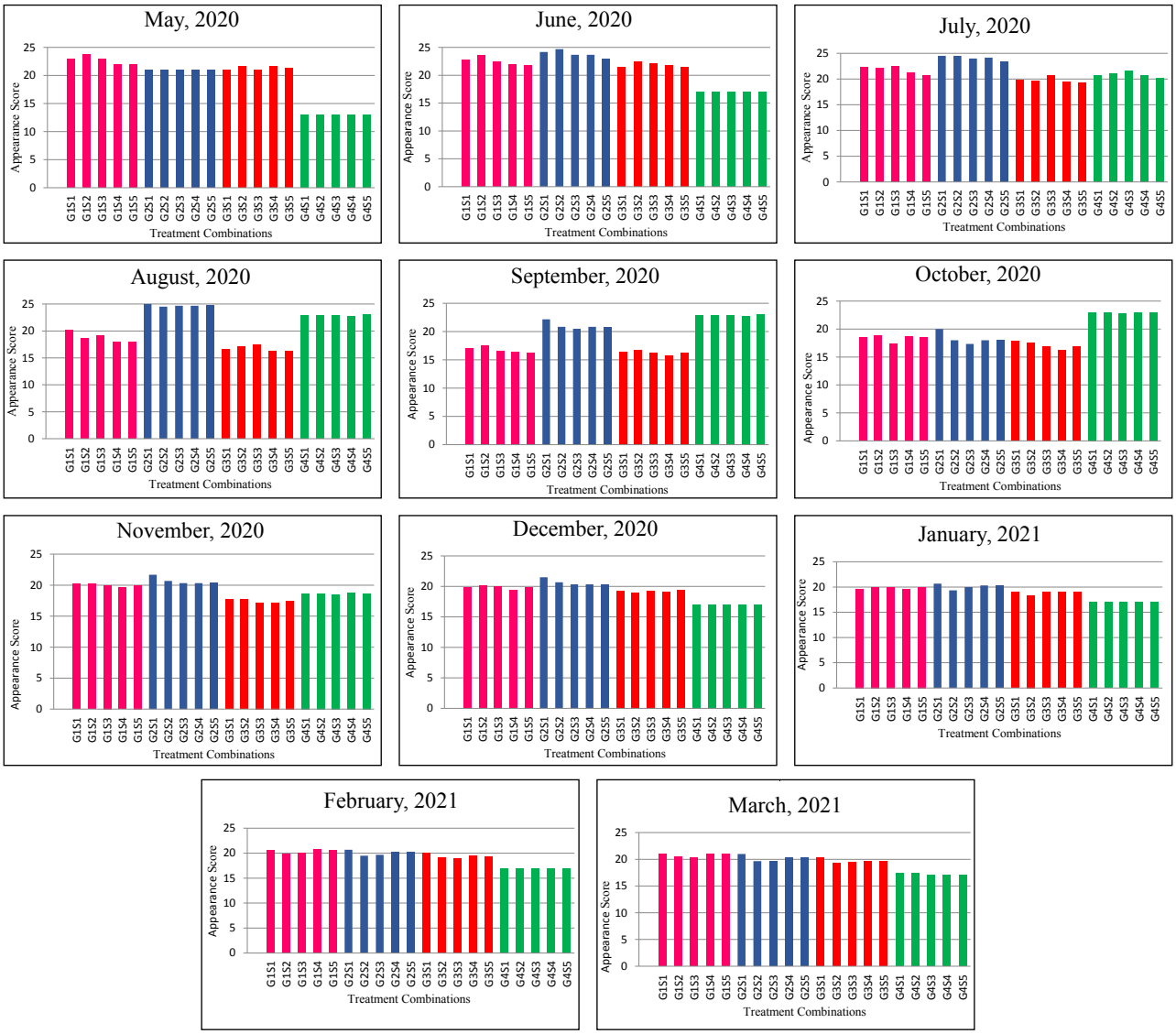

Fig. 1. Graphical representation of monthly appearance of turf from May, 2020 to March, 2021. (X-Axis-G1-*'Lolium perenne'*, G2-*'Agrostis stolonifera'*, G3-*"Festuca rubra"* and G4-*'Cynodon dactylon'*, S1-Standard seed rate, S2-5% increased seed rate, S3-5% reduced seed rate, S4-10% reduced seed rate and S5-15% reduced seed rate) (Y-Axis- Appearance score on basis of turf colour, turf texture (hand feel method, visual texture,turf spread and diseases and insect-pest incidence.

genotype and seed rate revealed that among different genotypes evaluated, minimum days taken for turf establishment were exhibited by *'Lolium perenne'* (G_1) when sown with seed rate (S_2) i.e. 5% increased seed rate which was found to be at par with (G_1S_1) while, maximum days for turf establishment were exhibited by *"Cynodon dactylon"* (G_4) when sown with seed rate (S_5). In the present studies, 5% increased seed rate took minimum days for turf establishment in all the genotypes. The results are in line with the findings of Minner *et al*. (10) who stated that variation in seed rate greatly affected the population and increased seed rate was more influential in case of *Lolium perenne.*

From March, 2020 to March, 2021 maximum number of mowings (twenty-three mowings) were required by *'Lolium perenne',* followed by *"Festuca rubra"* which required eighteen mowings and the least number of mowings (thirteen mowings) were required by *'Agrostis stolonifera'* and *'Cynodon dactylon'.* These results are in accordance with the findings of Verma (15) who reported that due to vigorous growth and increase in culm length after establishment, *Lolium perenne* and *Festuca rubra* required maximum number of mowings.

Weeds namely, *Cyperus rotundus*, *Trifolium repens*, *Capsella bursa-pastoris*, *Euphorbia crusgalli*, *Chenopodium album*, *Amaranthus viridis*, *Digitaria sanguinalis*, *Gallinsoga parviflora* etc were found infesting the lawn grasses most prominently

Minimum weed count (84.90/m^2) was observed in *'Agrostis stolonifera'* (G_2) while maximum weed count (148.17/m^2) was observed in *"Festuca rubra"* (G_3). Amongst the different seed rates, a minimum weed count (93.08/m^2) was observed in 5% increased seed rate (S_2), whereas, 15% reduced seed rate (S_5) recorded maximum weed count (137.25/m^2). These results are in corroborative with the findings of Bo (1) who stated that *Festuca rubra* with reduced ground (28% to 84% only) had increased weed infestation and Mathew (9) concluded that Bermuda grass showed less number of weeds and high ground cover score.

During summer's maximum chlorophyll content (1.84mg/100g) was obtained by *'Lolium perenne'* (G_1) while, minimum chlorophyll content (0.86mg/100g) was obtained by *"Festuca rubra"* (G_3). During autumn season maximum chlorophyll content (0.61mg/100g) was obtained by *'Agrostis stolonifera'* (G_2) while, minimum chlorophyll content (0.30mg/100g) was obtained by *"Cynodon dactylon"*(G_4). During winter season maximum chlorophyll content (0.61mg/100g) was obtained by *'Agrostis stolonifera'* (G_2) while, minimum chlorophyll content (0.29mg/100g) was obtained by *"Cynodon dactylon"*(G_4) and was at par with *"Festuca rubra"* (G_3). During spring season maximum chlorophyll content (1.56mg/100g) was obtained by *'Agrostis stolonifera'* (G_2) while, minimum chlorophyll content (0.93mg/100g) was obtained by *"Festuca rubra"* (G_3). Study revealed that variation in seed rate had no effect on chlorophyll index (Table 5) and the same was concluded by Madison and Andersen (7). *'Lolium perenne'* had more chlorophyll content as compared to *"Festuca rubra"* except for the month of September, 2020 (autumn season). *"Cynodon dactylon"* recorded lowest chlorophyll content when its colour changed from Green group to Yellow green group to Orange white group during September, 2020 (Autumn season) and December, 2020 (Winter season). Similar results have been reported by Li *et al*. (6) who stated that the colour of grass was greener when chlorophyll contents were higher on the contrary, the colour was lighter. In general *"Cynodon dactylon"* which is considered to be a warm season grass species had minimum chlorophyll content during the winters and *"Festuca rubra"* the cool season lawn grass had minimum chlorophyll content during summer season that is June, 2020, depicting that cholorophyll content is directly related to the nature of the species.

Table 5. Effect of different seed rates and genotypes on chlorophyll content during different seasons of the year (mg/100g).

	June, 2020					September, 2020					December, 2020					March, 2021				
	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean
S_1	1.74	1.86	0.81	1.31	1.43	0.45	0.64	0.52	0.42	0.51	0.44	0.46	0.38	0.31	0.40	1.17	1.44	1.03	1.14	1.19
S_2	1.92	1.66	0.82	1.45	1.46	0.50	0.57	0.52	0.22	0.45	0.49	0.80	0.36	0.31	0.49	1.22	1.61	0.99	1.18	1.25
S_3	1.89	1.47	0.86	1.50	1.43	0.52	0.62	0.59	0.18	0.48	0.43	0.67	0.32	0.27	0.42	1.26	1.49	0.83	1.27	1.21
S_4	1.84	1.81	0.87	1.61	1.54	0.49	0.58	0.52	0.33	0.48	0.53	0.49	0.33	0.27	0.40	1.22	1.63	0.84	1.14	1.20
S_5	1.81	1.49	0.96	1.63	1.48	0.50	0.66	0.58	0.37	0.53	0.49	0.60	0.35	0.28	0.43	1.24	1.62	0.95	1.24	1.27
Mean	1.84	1.66	0.86	1.50	1.47	0.49	0.61	0.54	0.30	0.49	0.48	0.61	0.35	0.29	0.43	1.22	1.56	0.93	1.19	1.22
$CD_{0.05}$ for:																				
Genotypes	= 0.13									= 0.06					= 0.07					= 0.16
Seed Rates	= NS									= NS					= NS					= NS
Genotypes × Seed Rates	= NS									= NS					= NS					= NS

G_1 – *Lolium perenne*
G_2 - *Agrostis stolonifera*
G_3 – *Festuca rubra*
G_4 –*Cynodon dactylon*

Perusal of data reveals that *'Agrostis stolonifera'* (G_2) exhibited best appearance with the highest score (21.36), whereas, *"Cynodon dactylon"*(G_4) scored lowest score (18.76) and was at par with *"Festuca rubra"* (G_3). Graphical representation of monthly appearance from May, 2020 to March, 2021 were plotted (Fig. 1). Quality evaluation was done on the basis of Turf colour (colour chart of 'The Royal Horticulture Society", London), turf texture (hand feel method by Srivastava and Kumar (13), visual texture, turf spread and diseases and insect-pest incidence/m^2 (Verma, 15). *"Cynodon dactylon"* and *"Festuca rubra"* attained lowest score during the study. Similar findings were made by Martiniello and D'Andrea (8) who reported that Red fescue subspecies achieved lower scores in turf quality, colour and cover in spring and summer, than perennial ryegrass. Other studies conducted by Yang *et al*. (16) concluded that *Lolium perenne'* had an extended green period and performed better compared to other species. *'Agrostis stolonifera'* could not resist the high temperature in summer. *"Cynodon dactylon"* was resistant to disease, insect and heat, however its overwintering rate was lower and green period was short and similar were the results obtained in the study. From May, 2020 to March, 2021, *'Agrostis stolonifera'* was the best performing genotype followed by *'Lolium perenne'* whereas, lowest score was attained by *"Cynodon dactylon"* and '*'Festuca rubra"*. These results were in close proximity with findings of Kusvuran and Tansi (5) who concluded that Creeping Bentgrass attained high scores for turf quality, colour and coverage followed by perennial ryegrass whereas red fescue including all its subspecies and varieties was the most negatively affected grass during high temperature.

AUTHORS' CONTRIBUTION

Conceptualization of research work and design of experiment (AA, JSW, RB); Execution of lab/field experiment and data collection (AA, JSW); Analysis of data and interpretation(AA, JSW, RB); Preparation of manuscript (AA).

DECLARATION

The authors declare that there is no conflict of interest.

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