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Sithin MathewK. R. C College of Horticulture,
Arabhavi, Karnataka, India**GK Seetharamu**College of Horticulture,
Bengaluru, Karnataka, India**M Dileepkumar**K. R. C College of Horticulture,
Arabhavi, Karnataka, India**D Satish**College of Horticulture Bagakot,
Karnataka, India

Grasses for sports grounds and its influence on playing quality: A review

Sithin Mathew, GK Seetharamu, M Dileepkumar and D Satish

Abstract

Turf grasses are the crops which has huge economic value in outdoor sports and recreations. It is very unbearable to imagine many of the sports games without a green carpet of grasses. Many of the front-line sports like golf, football, cricket, rugby, baseball, tennis, hockey, lacrosse, croquet, lawn bowling *etc.* are played on grass courts. Grasses reduces the risk of injury, while playing by acting as a natural cushion. Grasses play a vital role in providing better locomotory movements to the players, and smooth ball role characteristics. The quality of the game is always influenced by the height, texture, firmness and growth habit of the grasses. Selection of grasses and its maintenance is of prime importance.

Keywords: Turf grasses, sports games, texture, injury, locomotory movements

Introduction

Turf grasses are the heart of garden and the centre for social life (Jenkins, 1994; Maria, 2015; De, L. C 2017) ^[18, 26, 11]. As any sports fan will agree, player performance depends in large part on the quality of turf surface and all these considerations largely depends on three turf characteristics: traction, hardness and evenness (Puhalla *et al.*, 1999) ^[36]. Selection of grasses is very important because it should fulfil the characteristics of the game, it should perform well in the climatic condition prevailing in that area and it should not interrupt in performance of the players (SAI). 'Ball pace', 'Ball bounce' and 'Ball roll' characteristics were perceived to change significantly between surfaces, especially between surface types and many players. (Ronkainen *et al.*, 2012) ^[38].

Qualities of turf grasses for sports grounds

As any sports fan will agree, player performance depends in large part on the quality of turf surface and all these considerations largely depends on three turf characteristics: traction, hardness and evenness (Puhalla *et al.*, 1999) ^[36]. As stated above, traction is one of the two main surface characteristics that may relate to injury in football. Traction relates to the type of footing or grip a playing surface provides (Nigg, 1988; Ekstrand, 1989; Rogers, 1990; Milburn, 1998; Leonie *et al.*, 2007) ^[30, 13, 37, 28, 25]. Traction is most highly correlated with grass cover, hardness and soil moisture content (Stanitski *et al.*, 1974; Bell and Holmes, 1988; Baker, S. 1991; Leonie *et al.*, 2007) ^[43, 2, 25]. According to (Janakiram *et al.*, 2015) ^[16] turf grass used in sports grounds should possess 'medium texture, dense cover, spreading growth habit, rapid recovery, lack of dormancy and local availability. In sports turf canopy density may become limited on baseball infields, lawn bowling greens, grass tennis courts, and other areas where close mowing heights are used (Puhalla *et al.*, 1999) ^[36]. a significant relationship between ground hardness and speed of the game, with faster speeds on harder grounds (Norton *et al.*, 2001; Leonie *et al.*, 2007) ^[31, 25].

Establishment of Grasses in Sports Grounds

Grasses can be established in different ways *viz.*, seed sowing, sodding, sprigging and hydro seeding.

Seed sowing: it is the cheapest method of grass establishment for areas. Adding native plants as seeds, rather than as container plants, may be a cost-effective restoration method, especially in remote areas or across large regions (Lengyel *et al.*, 2012; Kimball *et al.*, 2015) ^[24, 22]. Better root anchorage and fast establishment makes it a good option for sports ground establishments. Commercially available seed spreaders are used for uniform broadcasting of seeds (Puhalla *et al.*, 1999; John, 2016) ^[36, 19].

Sprigging/dibbling: it is the oldest method of grass establishment which gives very good establishment and uniformity. But it is very time consuming and labour intensive.

Corresponding Author:**Sithin Mathew**K. R. C College of Horticulture,
Arabhavi, Karnataka, India

Transportation of planting material is also a big challenge for dibbling because dibbles with soil are very heavy in weight (Puhalla *et al.*, 1999; John, 2016) ^[36, 19].

Sodding/turfing: sodding is the most common grass establishment technique used now a days. Fast and highly uniform establishment makes it more popular among all the methods. Poor root establishment makes poor performance of the turf during winter months (Puhalla *et al.*, 1999) ^[36].

Hydroseeding: hydroseeding is the latest method of grass establishment in the sports grounds. Here seeds are mixed with a mulch solution in a definite proportion and the mulch along with seeds are sprayed to the ground uniformly. Mulch will protect the seeds from sunlight and provide moisture until seed germination. Mulch material usually used is newspaper mulch which is made in to a solution (John, 2016) ^[19].

Grasses for Main Sports Games

Cricket Grounds: Presence of grass in the central pitch will affect moisture level on the ball which will ultimately affects bounce, speed, swing, and spin of the ball. Grasses binds the soil in pitch which helps in prevention of cracking of the pitch and prevent variation of spin of the ball. Height of mowing of grass in cricket ground is 3-5 cm (out yards). Grasses used in cricket field should possess deep root system up to 15 cm so it can absorb the moisture from soil depth of 15 cm and it helps in fast drying up of the ground after rainfall (White, 1998) ^[49]. Bermuda, rye grass (fewer deep roots) and annual rye grass is better in warm areas. Whereas, *Lolium perenne* is widely used in cool areas (Janakiram *et al.*, 2015) ^[16].

Football Grounds: Grass used in football ground must provide firm footing, resistance on impact and resistance to tearing. Football grounds are highly prone to injury of grasses; hence vigorously growing grasses are preferred because it helps in rapid recovery after injury (Trenholm *et al.*, 2000) ^[47]. High thatch forming grasses like Kentucky blue grass and Perennial rye grass is widely used because it helps in reducing the risk of injury by thatch formation which acts as a natural cushion on impact. Bermuda grass is used in warm areas like Indian subcontinent along with overseeding with perennial rye in rain fall. Tall fescue grass is used for less maintenance fields like low mowing, low irrigation *etc.* Mowing height of a normal football ground is 2 to 2.5 inch. (Janakiram *et al.*, 2015) ^[16].

Rugby Grounds: Bermuda grass and Kikuyu grass are widely used in warm areas while Perennial Rye grass is used in cool areas. Rugby involves high foot traffic and high torque will act on the players foot while playing (Stephanie and Felix, 2014) ^[45]. Hence the grasses used are common thatch forming grasses to reduce the risk of injury by cushioning effect. Height of mowing of grass is 15 – 25 mm. Surface hardness of 4 – 15 IV for local competition and 4 – 12 IV for premier and elite levels are maintained in rugby grounds. Surface hardness is measured using an instrument called Clegg Impact Hammer which works on the principle of Newtons third law (Sleat *et al.*, 2016) ^[41].

Tennis Grounds: Tennis ground requires maintenance more than any sports grounds, it is maintained in daily basis. The playing area is very less and it receives high foot traffics hence after each and every matches maintenance is followed. Height of mowing is very important because height and

texture of grass will affect the bounce of the ball (Miller, 2006) ^[29]. The standard mowing height of tennis court is 0.5 cm. Hence care should be taken while selecting grasses, because the grasses should be resistant to law height mowing. Creeping bent grass with over seeding with perennial rye grass is the widely used grass combination. Wimbledon tournament uses mix of 70% perennial rye grass and 30% creeping red fescue. In warm areas: ‘Tif dwarf’ and ‘princess 77’ varieties of Bermuda grass are widely used whereas in cool areas Perennial rye grass and Creeping red fescue is very good option (Janakiram *et al.*, 2015) ^[16].

Hockey Grounds: Height of mowing plays a major role in hockey because more height of grass affect the ball rolling and it may interfere in speed of the game (Sharma and Dasnd, 2017) ^[39]. The standard mowing height is 1.5 cm. Regular scarification is followed to prevent sponge like effect and to give firmness to the surface. Bermuda grass and Kikuyu grass is widely used in warm areas while perennial rye grass is used in cool areas. Astro turfing or artificial turfing is becoming very famous in hockey grounds due to easy maintenance and more popularity of indoor games where natural grasses are difficult to maintain (Janakiram *et al.*, 2015) ^[16].

Base Ball: Kentucky bluegrass, Tifway 419, Bandera, Bull's Eye and Riviera varieties of Bermuda grass are very common in Baseball fields. Mowing height is 1 to 2.5 inch. High wear tolerant and thatch forming grasses are used because of high wear and tear acting on the ground due to high foot traffic and it will reduce the risk of injury while falling (Kinsella, 2003) ^[23]

Golf Courses: An estimated 32,000 golf courses are present worldwide which comprises approximately 25,600 km² area (Susan *et al.*, 2016) ^[46]. One golf course may comprise of 30-60 ha area. According to (Watkins *et al.*, 2010) ^[48] evaluation of grasses for golf fairways based on resistance to different stress (Table 1) suggest that under extreme stress condition like lowest mowing height (1.90 cm) and highest number of passes (6 passes per week) velvet bent grass recorded highest turf quality score (7.1) during 2006 while during 2007 sheeping fescue (5.7) performed superior. Golf courses comprises of different playing surfaces *viz.*, Green, tees, fairways, and rough (Pernilla *et al.*, 2017; Wurl, 2019) ^[33, 50].

Greens: These are very closely mowed turfs to provide smooth ball roll characteristics. The mowing height is very low which helps in better ball rolling. Resistant to impact of ball and capacity to hold the weight of the ball are important characteristics of the grasses which are used in golf greens. *Agrostis stolonifera*, *Poa annua*, Tif green variety of Bermuda grass, *Zoysia* sp. and *Paspalum notatum* are the widely used grasses in golf greens

Golf Tees: Mowing height is 1 to 2.5 cm. These are leveled and firm spaces to make tee shots. Should resistant to heavy traffic because here player will stand and make long shots using tees and grasses should be fast in recovery from injury.

Golf Fairways: These are the largest playable area in golf courses with 30-60 acres. Characterized by the presence of Hazards or obstacles like Water and Bunks on which player should find his target by overcoming these obstacles. Grasses used are Mix of Kentucky blue grass and Perennial rye grass in cool areas, while in warm areas Bermuda grass, *Zoysia* grass and buffalo grass is used in less maintained and non-irrigated areas.

Roughs: These are non-playable areas of golf courses. Laid out at boundaries of the golf courses. Mowing height followed is more than 5 cm. Grasses used are Kentucky blue grass and Kikuyu grass in warm areas, Kentucky grass + Fine fescue under shade and Buffalo grass under nonirrigated areas. (Janakiram *et al.*, 2015) [16]

Astro-Turfing

They are composed of polypropylene fibers of varying lengths stabilized with ground rubber and/or sand infill, and supported on an engineered foundation (Kevin *et al.*, 2006) [21]. First used in 1976 Montreal Hockey Olympics (Burgers, 2014) [7]. UEFA and FIFA accepted the use of third-generation artificial turf for official tournaments in 2005. FIH (Federation of International Hockey) also Certified (AstroTurf is an FIH Preferred Provider) the use of astro turf (Sheppard 2014) [40]. More popularity of indoor games now a days widely accept the use of astro turfing. Maintenance and survival of natural grasses in indoor condition is not always practical. performance response is a combination of shockpad type, density and thickness, carpet detail (fiber length, type, and weight/density) and infill types and depths (Dixon *et al.*, 2015; Fleming *et al.*, 2016) [12, 14]. Whereas Polyethylene is less expensive, less abrasive, less durable, less resilient than nylon and also it repels water (Peter and Enrique, 2009) [34]. The difference between natural and artificial grasses are shown in table 1.

Influence of Grasses on Playing Quality

Natural Cushion

Lawn thatch is the decaying matter of grasses which are not visible and having rhizomes and stolons of grasses running parallel to vegetative growth of grasses. It acts as a natural cushion and it will reduce the risk of injury and widely used in games which are having high risk of injuries (Orchard *et al.*, 2005) [32]. Rhizomatous grasses such as Kentucky blue grass, Perennial rye grass and *Zoysia* grass is widely used due to their high thatch forming nature. Analysis of AFL injuries reveals that the rate of ACL injury is significantly lower on grounds that have perennial ryegrass as the major species, compared to Bermuda grass (Orchard *et al.*, 2005; Chivers, 2005) [32, 10].

The injuries reported per 10,000 exposures (figure 1) was highest in artificial grass surfaces compared to natural grass surfaces. Artificial grass surface which are filled with rubber granules reported higher injuries due to high torque acting on the leg in response of rapid turn and movement of the player due to high friction possessed by the rubber granules. Acute non-contact injury was occurred without any collision between two players which means it is exclusively due to the surface quality and difference of torque level acting on the surface. The injury was highest in Artificial turf than in Natural turf (figure 2) because of the poor surface quality of the artificial turf surface which increased the incidence of injury (Jason *et al.*, 2013) [17].

Ball Skills and Locomotory Action in Soccer

Frequency of path changes, headed pass, clearance, aerial challenges *etc.* were highest in softer playing surface compared to harder surface. Playing surface can influence the shooting accuracy and kinematics (Potthast & Bruggemann, 2010; Keeron *et al.*, 2014) [35, 20] and plantar loading during agility tasks (Ford *et al.*, 2006; Keeron *et al.*, 2014) [20]. a significant relationship between ground hardness and speed of the game, with faster speeds on harder grounds (Norton *et al.*,

2001; Leonie *et al.*, 2007) [31, 25]. The total distance covered by a player (figure 3) was highest in natural grass compared to artificial grass and the number of sliding tackles (figure 4) was also highest in natural grasses because in artificial grass there was a risk of injury so players did not make attempt of sliding tackle. High number of short passes and ball possession (Table 2) was highest in artificial grass compared to natural grass because of less sliding tackles in artificial grass due to which the opposite team will possess the ball for long time with short passes. But the number of shots on the goal post and goals scored was highest in natural grasses. Hence the game was less aggressive in artificial grass compared to natural grass and it resulted in poor response of the players about artificial grasses compared to natural grasses when questions were asked about match (Anderson *et al.*, 2008) [1].

Dynamic Behavior of the Cricket Ball

The dynamic behavior of the ball is influenced by two forces acting on the ball after impact of the ball on the pitch, which are frictional force acting on the horizontal direction and reactional force acting on vertical direction (figure 5). When the reactional force is less frictional force will be high and vice-versa. Based on these two forces acting on the ball different pitches behaves like batting friendly and bowling friendly pitches (Carre *et al.*, 2002) [9].

pace remained unclear. In New Zealand, McAuliffe & Gibbs (1997) [27] collected objective measurements on the pace and bounce of first-class cricket pitches. They used a crossbow-type ball launcher to project cricket balls onto prepared pitches and measured the rebound trajectory with an array of laser diodes. Correlations were found between grass cover and pace.

Velocity ratio and top spin gained (figure 6, a and b) by the ball is inversely proportional to each other. Among 14 grasses evaluated (Table 3) high velocity ratio was shown by 'Gator' variety of Perennial rye grass while the same variety recorded lowest top spin gained it is attributed to the fact that when pitch produces high velocity the time taken for interacting with the pitch will be less which reduced the topspin gained. Likewise, 'Barcrown' variety of creeping fescue shown less velocity and more top spin gained due to more contact with the pitch which increased the top spin. The simulated trajectory analysis (figure 7) of pitch showed that 'SGP-12' variety of perennial rye grass recorded highest bounce and 'Lance' variety of bent grass recorded lowest bounce due to difference in texture of grasses (Carre *et al.*, 2002) [9].

Dribbling and Hitting Test in Hockey

Harbhajan Singh's Dribbling and hitting test is used to measure quality and speed of the players as well as the playing surface. Here the player is made to dribble the ball from one end to another end of a line drawn perpendicularly having length of 10 meter (Figure 8). Along the length of the line Eight poles will be arranged and the player has to dribble the ball in between the poles in a zig-zag manner and when he reaches the opposite end, he has to make a shot towards the starting point. The time taken by each player for this activity is recorded separately and the administration of the data (figure 9) revealed that players evaluated on both grass surfaces shown significant difference in time taken for dribbling and shot and it revealed that grass court recorded better playing skill than that of artificial grasses (Sharma and Dasnd, 2017) [29].

Wimbledon: A Fast Surface

Tennis is played in different surfaces like clay, rebound ace, deco turf and grass courts. Among them rebound ace and deco turf are synthetic courts which is used in famous grand slams like Australian open and US open respectively. While French open is played in clay court and Wimbledon is played under grass court. There exists a wide variation of bounce of the ball among all types of courts which depends on the COR (Coefficient of resistance) acting on the ball. Co-efficient of resistance of grass court is very less inducing a lower height of the vertical bounce (Brody, 2003) ^[6] which makes the

players to run fast and take the shots due to which it acts as a “fast surface” which delivers an aggressive game. Winning percent on first shot, serving points won, Aces, Break point conversions and Net approaches were highest in grass court compared all other courts (table 4) which makes grass court more popular (Barnett and Pollard, 2007) ^[3]. Average duration of the rally at Wimbledon (3.8 s) is very less compared to the French Open (7.3 s) and also lower number of retired matches were noticed in Wimbledon due to less risk of injury, Breznik and Batagelj (2012) ^[5].

Table 1: Comparison of artificial and natural grasses for different attributes of sports events

Artificial grass	Natural grass
Less maintenance (Steffen <i>et al.</i> , 2007, Burgers, 2014, Caglayan 2019) ^[44, 7, 8]	High maintenance (Burgers, 2014) ^[7]
Long durability (Burgers, 2014) ^[7]	Less durability (Burgers, 2014) ^[7]
High risk of injury (Jason <i>et al.</i> , 2013, Caglayan 2019) ^[17]	Less risk of injury (Jason <i>et al.</i> , 2013, Caglayan 2019) ^[17, 8]
Difficulty in locomotory movements (Caglayan 2019) ^[8]	Support locomotory movements (Caglayan 2019) ^[8]
High wear tolerance (Burgers, 2014) ^[7]	Less wear tolerance (Burgers, 2014) ^[7]
Distorted ball control (Andersson 2008) ^[1]	Better ball control (Andersson 2008) ^[1]

Table 2: Turf grass quality and percent living stand density for species maintained at 1.90 cm receiving six passes of traffic per week

Species	2006 Turf quality ^z	2007 Turf quality ^y	2007 Percent living Stand density ^x
Sheep fescue	4.0 ef ^w	5.7a	76.5 abc
Chewing fescue	4.6 e	5.3 a	77.0 ab
Hard fescue	3.8 fg	4.5 b	63.3 cde
Colonial bent grass	6.1 b	4.5 b	83.8 a
Creeping bent grass	6.3 b	4.0 c	68.8 bcde
Tall fescue	5.5 cd	4.0 c	56.5 def
Kentucky blue grass	5.0 de	3.9 c	58.5 def
Velvet bent grass	7.1 a	3.7 c	69.8 bcd
Supine blue grass	6.0 bc	3.1 d	45.0 fg
Timothy	4.4 e	3.1 d	60.3 def
Perennial ryegrass	5.3 d	2.4 e	35.8 gh
Canada bluegrass	2.5 i	2.2 e	24.8 hi
Redtop	2.8 hi	2.2 e	56.0 ef
Tufted hairgrass	3.4 fgh	2.1 e	11.8 ijk
Rough bluegrass	3.2 gh	1.2 f	3.75 jk
Alkaligrass	1.8 j	1.2 f	0.0 k
Annual bluegrass	4.1 ef	1.1 f	2.0 jk

Table 3: Ball skills and technical standard on artificial turf and natural grass

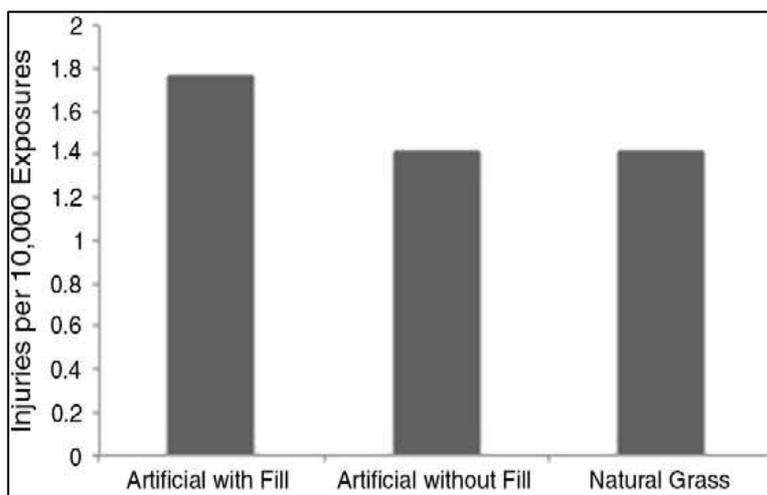
	Artificial turf		Natural turf		P-value
	Total (n)	Mean + s _x	Total (n)	Mean + s _x	
All passes	2437	304.6 + 14.5*	1993	249.1+15.9	0.00
Short passes	1740	217.5 + 14.0*	1338	167.3+14.9	0.00
% short passes of all passes		71.2 + 1.6		67.0 + 1.7	0.54
% unsuccessful short passes		16.7 + 1.6		17.5 + 2.9	0.85
Long passes	697	87.1 + 5.4	655	81.9 + 6.3	0.25
% long passes of all passes		28.8 + 1.6		33.0 + 1.7	0.54
% unsuccessful long high passes		58.9 + 3.2		56.7 + 1.6	0.77
% unsuccessful long low passes		36.6 + 3.7		26.8 + 3.1	0.13
Passes from defense to defense	241	30.1 + 2.5	225	28.1 + 3.6	0.46
Passes from defense to midfield	187	23.4 + 2.7	170	21.3 + 2.6	0.37
Passes from midfield to midfield	1186	148.3 + 11.0*	859	107.4+ 8.0	0.00
Passes from midfield to offence	366	45.8 + 3.6	331	41.4 + 4.8	0.19
Passes from offence to offence	369	46.1 + 4.7	333	41.6 + 5.1	0.17
Receptions	1785	223.1+ 18.0*	1245	155.6+17.0	0.00
Crosses	158	19.8 + 1.4	143	17.9 + 2.0	0.39
Unsuccessful crosses	118	14.8 + 1.1	97	12.1 + 1.7	0.16
% unsuccessful crosses of all crosses		75.1 + 4.6		67.7 + 3.9	0.27
Free kicks	98	12.3 + 1.7	97	12.1 + 1.9	0.94
Shots on goal	105	13.1 + 0.9	114	14.3 + 1.1	0.54
Goals scored	11	2.2 + 0.7	13	2.6 + 0.5	0.68

Table 4: Codes used to refer to grass types

Grass name	Grass species	Code
Lorina	Perennial ryegrass	1
Majestic	Perennial ryegrass	2
Master	Perennial ryegrass	3
Superstar	Perennial ryegrass	4
SGP 12	Perennial ryegrass	5
Merci	Perennial ryegrass	6
Gator	Perennial ryegrass	7
Boston	Perennial ryegrass	8
Jetta	Perennial ryegrass	9
Elka	Perennial ryegrass	10
Limousine	Smooth-stalked meadow-grass	11
Lance	Browntop bent	12
Center	Chewings fescue	13
Barcrown	Slender creeping red fescue	14

Table 5: Grand Slam match statistics in 2004-2005.

	Sex	Roland Garros 2004 (Clay)	Australian Open 2005 (Rebound Ace)	US Open 2004 (Deco Turf)	Wimbledon 2004 (Grass)
Win percent on first serve (%)	Men	67.0	70.2	71.6	73.3
	Women	59.2	61.7	56.3	57.9
Serving points won (%)	Men	59.2	62.2	62.1	65.2
	Women	52.5	54.8	56.2	57.9
Aces (%)	Men	4.7	7.2	8.5	8.8
	Women	3.0	3.9	3.8	4.6
Break point conversions (%)	Men	44.5	41.0	41.5	36.4
	Women	51.0	48.7	48.3	44.3
Net approaches (%)	Men	26.4	28.3	30.4	33.4
	Women	17.6	18.1	21.4	21.9

**Fig 1:** ACL injuries by playing surface. Rates of injuries per 10,000 exposures on artificial surfaces with fill, artificial surfaces without fill, and natural grass

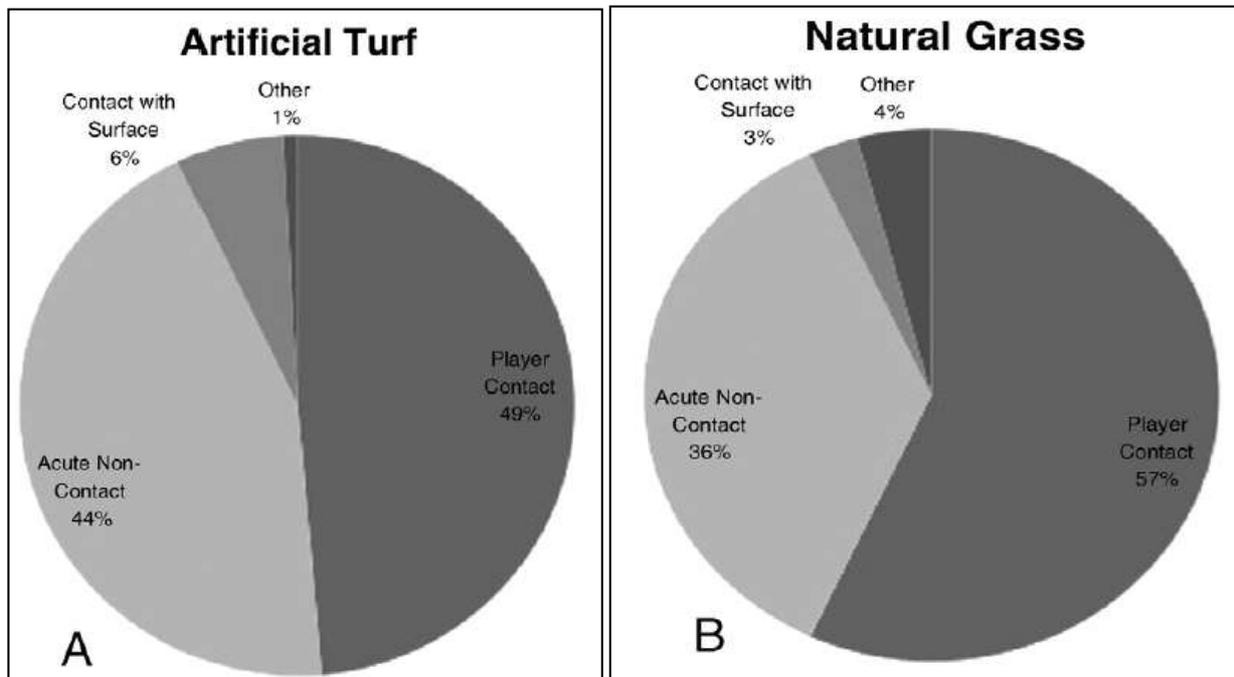


Fig 2: ACL injury basic mechanism. The basic mechanism of ACL injury on artificial turf (A) and natural grass (B).

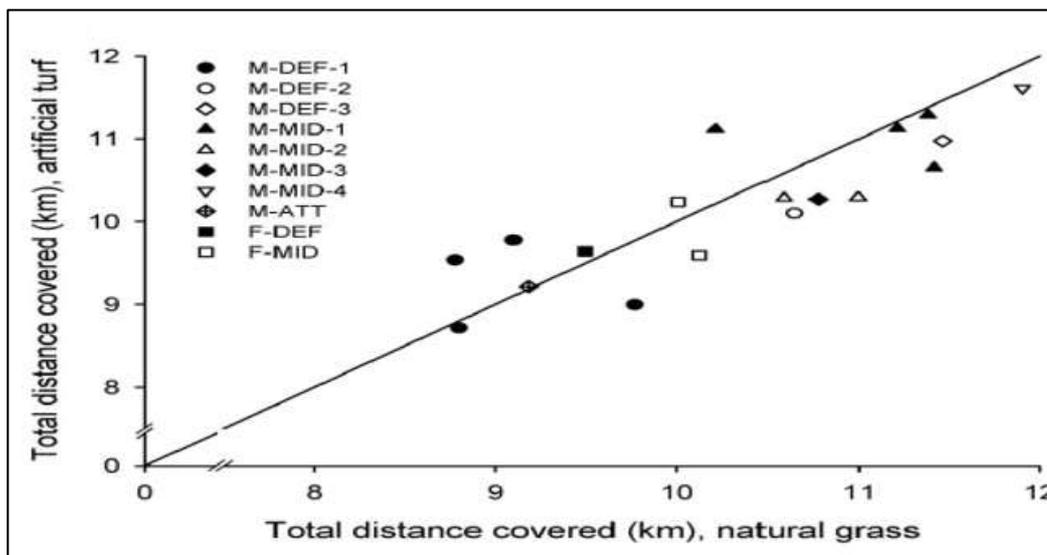
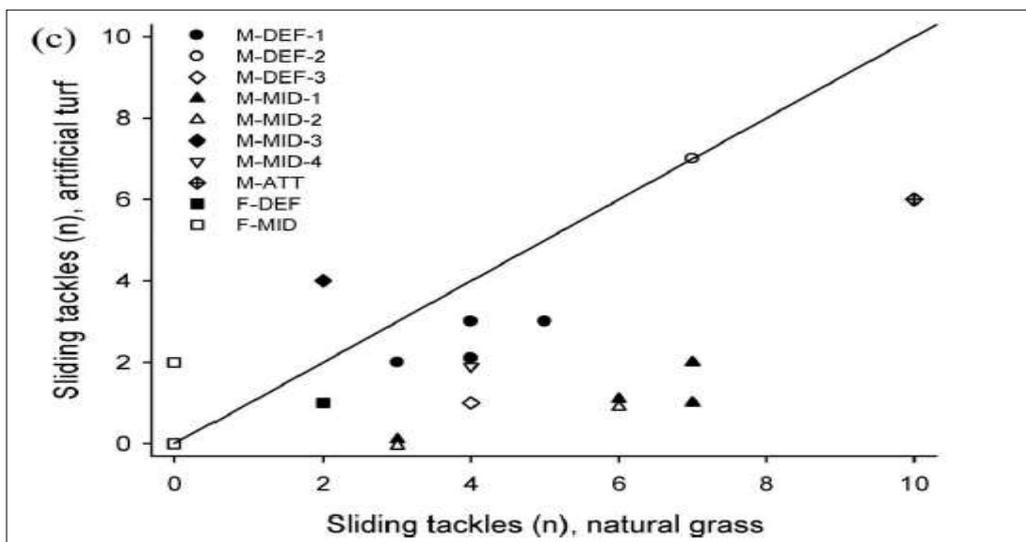
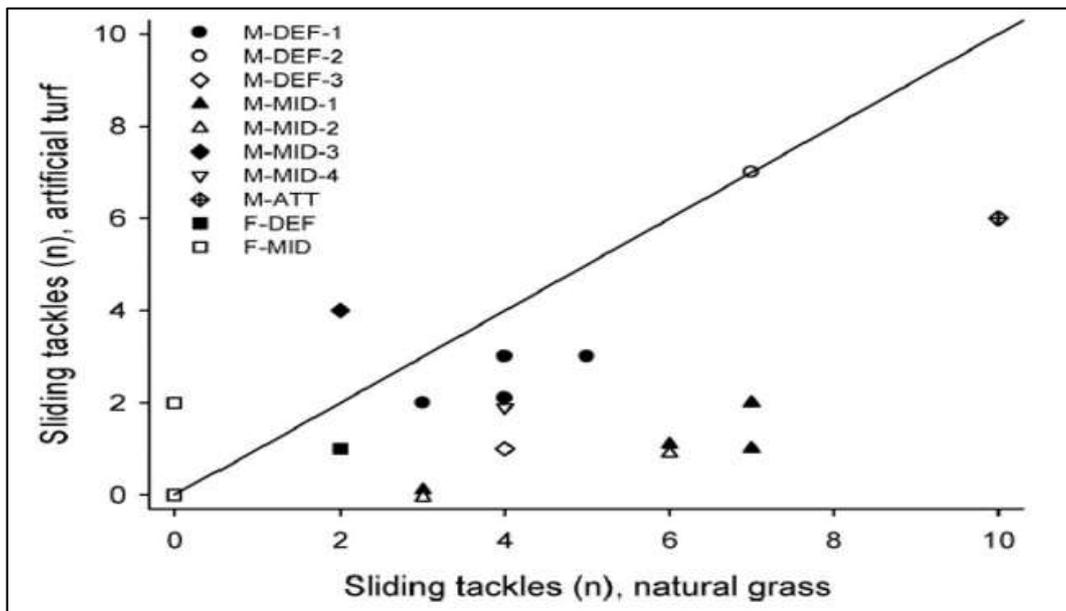


Fig 3: Total distance covered



A



B

Fig 4: Number of sliding tackles

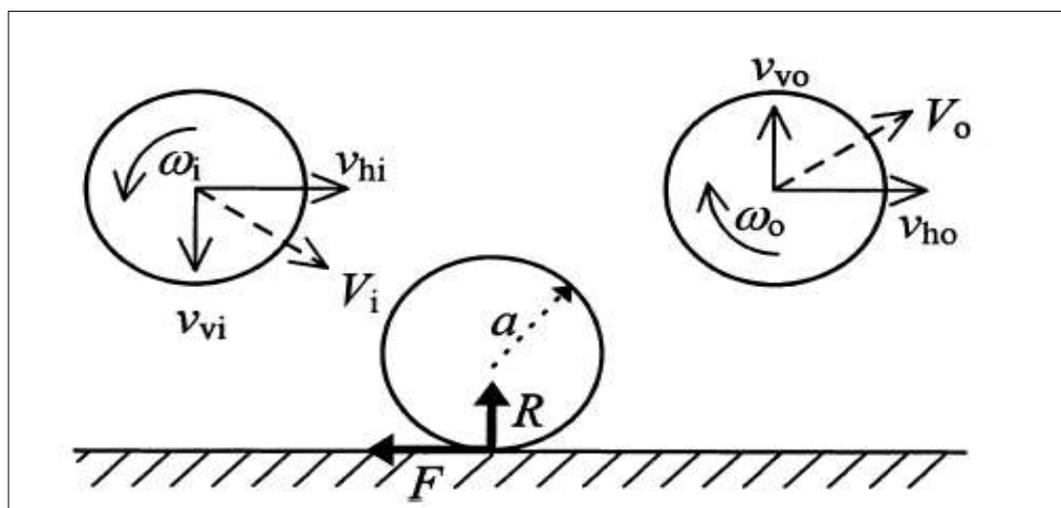
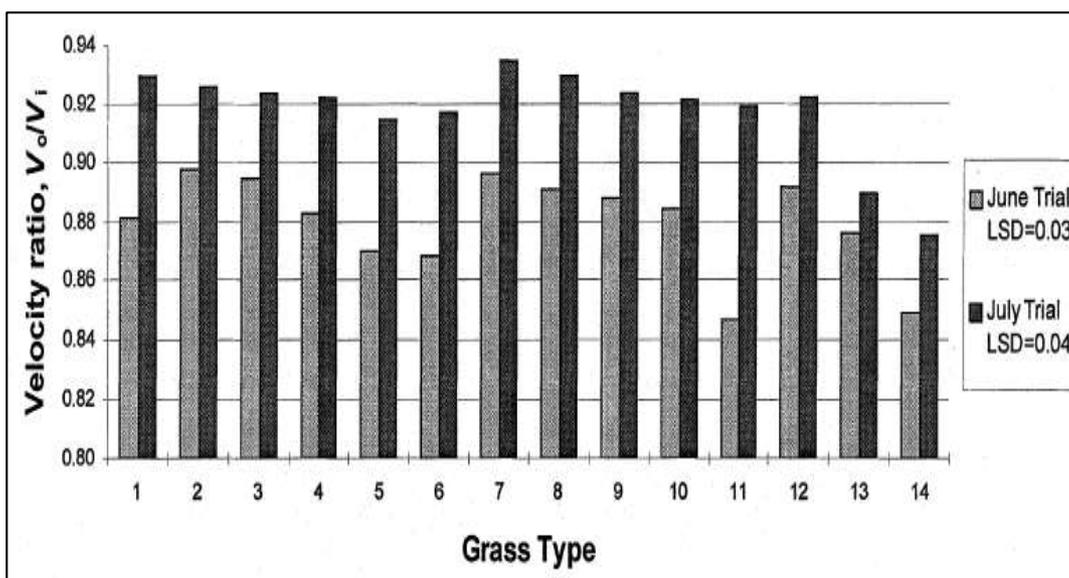
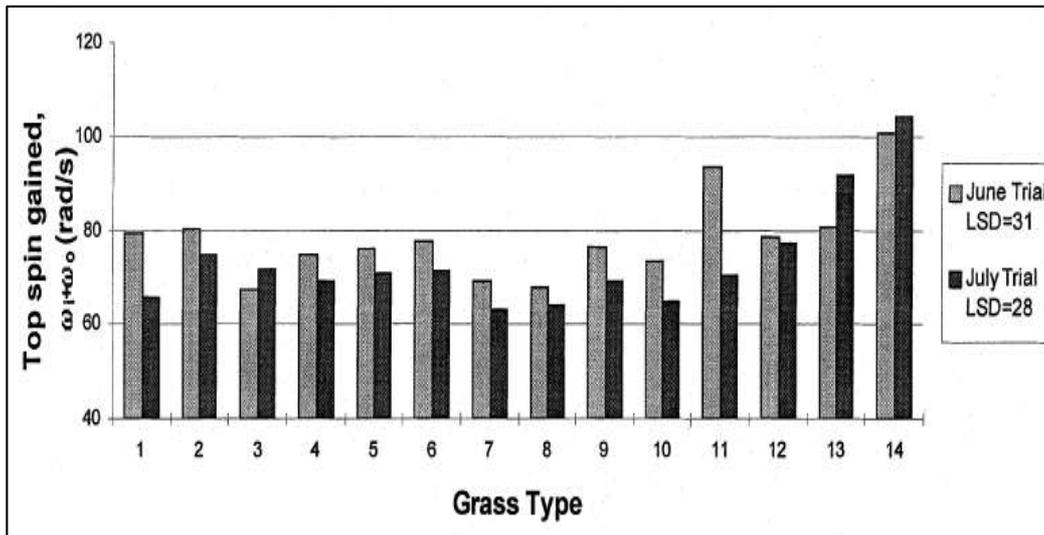


Fig 5: Dynamic behavior of the cricket ball influenced by friction and reaction force



A



B

Fig 6: (a) Velocity ratio, (b) top spin gained for grasses trials in June and July

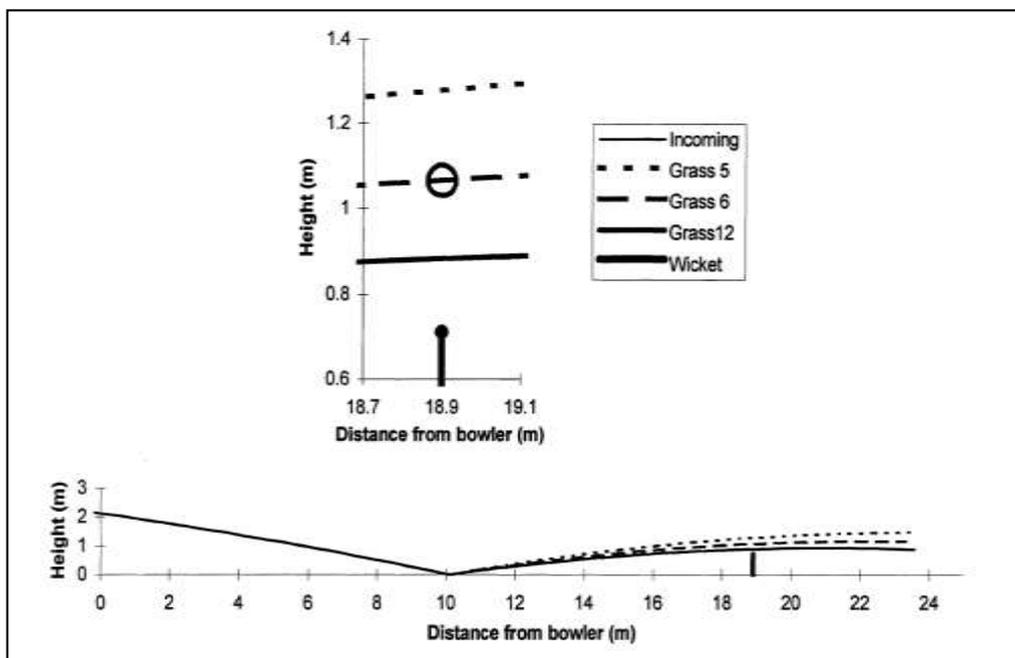


Fig 7: Simulated trajectories of impacts on different grasses based on averages of all trials

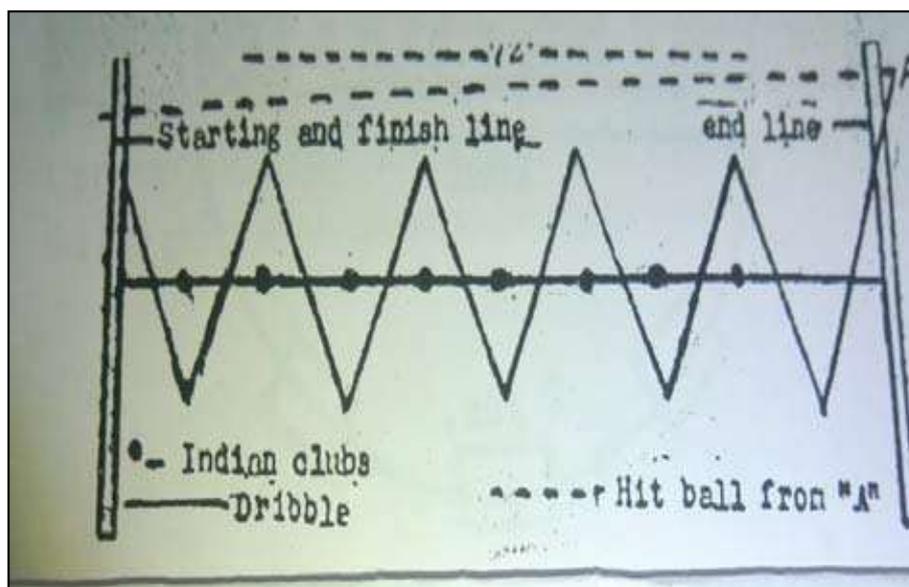


Fig 8: Harbhajan Singh's Dribbling and hitting test

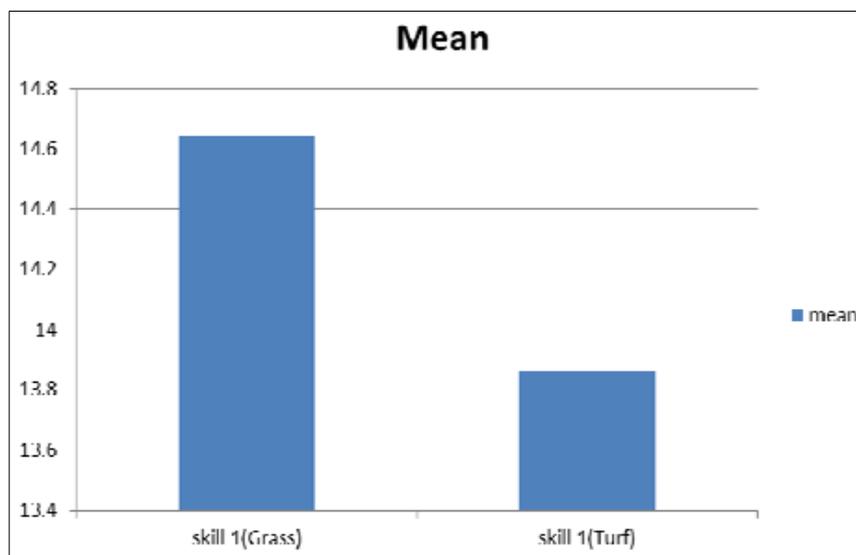


Fig 9: Graphical representation of mean of Harban's Singh Dribbling & Hitting Test between Grass and Turf Surface

Conclusion

Selection of grasses is very important for preparation of sports grounds because grasses vary from species to species. Among the temperate grasses' perennial rye grass and creeping fescue are widely used in different sports grounds and in warm areas Bermuda grass and kikuyu grass is widely used. The playing quality of games is highly influenced by the grasses will produce good ball roll characteristics, bounce, better locomotory movements and reduce the risk of injury by cushioning effect hence selection of grasses and their scientific management is very important to maintain the quality of the game.

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