ISBN-13: 978-1-897911-34-1 Editors: P.R. Fleming and S.E.Forrester

Quantitative assessment of cricket outfields in the Caribbean region

Francis B. Lopez and Louis E. Chinnery
Sports Agronomy Research Unit, Department of Biological and Chemical Sciences, The University of the West Indies, Cave Hill Campus, BB11000, Barbados
louis.chinnery@cavehill.uwi.edu

ABSTRACT

Desirable appearance characteristics on a cricket outfield include a visually attractive surface and uniformly green and healthy grass growth, while important performance characteristics include ball roll speed, surface hardness and field traction. Objective techniques are critical to provide a sound basis for assessments and advice with regard to outfield standards, grounds staff performance and the impact of innovations. In this study, one or more parameters were determined on cricket outfields to be used during ICC Cricket World Cup 2007 with the objectives of achieving a thorough sampling of field characteristics for uniformity testing and generating quantitative data for comparing different fields and field sections. Twenty-four locations were sampled on each field and measurements included soil moisture content, grass height, turf penetration resistance, chlorophyll index (a measure of field greenness) and ball roll distance using a modified stimpmeter. For all parameters, the standard error decreased as the number of sampling locations increased and 24 replications appeared to be close to the optimum for quantification of field characteristics with the selected sampling pattern. Large differences were observed in some cases between different sections of fields using visual mapping and statistical analysis techniques. The coefficient of variation tended to be high (over

20%) for turf penetration resistance and soil moisture content, and additional determinations at each sampling location are recommended for these parameters. Apart from the significant negative correlation between turf height and ball roll distance, no consistent correlations were observed among the parameters determined in this study. The field sampling pattern and parameters used in this study appear to be useful for quantitative assessment of cricket outfields in the Caribbean region.

INTRODUCTION

In order to attract international cricketing events, it is beneficial for Caribbean countries to demonstrate that sports fields in the region are of particular acceptable standards for appearance and performance. Important performance characteristics include ball roll speed, surface hardness and field traction, while appearance characteristics relate to the provision of a visually attractive surface including uniformly green and healthy grass growth (especially for television). Field uniformity is likely to affect both the speed and evenness of ball movement, two features that are very important in the quality rating of the cricket outfield (Adams and Gibbs, 1994). Objective methods for the assessment of cricket outfields are critical in order to demonstrate quality standards, guide management decisions, evaluate the impact of innovations, and optimize inputs so as to enhance economic and environmental sustainability. Some assessment methods may be wholly for diagnostic purposes while others may be more directly related to appearance and / or performance characteristics including player safety issues.

Some of the parameters of interest include soil moisture content, grass height, turf penetration resistance, chlorophyll index (a measure of field greenness) and ball roll distance measured using a modified stimpmeter (Lopez and Chinnery, 2009). Cricket fields developed for use during the International Cricket Council’s (ICC) Cricket World Cup 2007 in the Caribbean region had specifications for enhancing field drainage under heavy rainfall conditions while at other times promoting adequate moisture and nutrient retention in the root zone (Everett and Baker, 2007). Appearance characteristics are likely to be captured by measurements of grass height and chlorophyll index, while performance characteristics are likely to be indicated largely by ball roll distance, although turf penetration resistance may also give an indication of surface hardness. Measurements can be made at several points to give an indication of field consistency (uniformity over space), and repeated observations during and following field use can give an indication of durability (uniformity over time).

Soil moisture content, grass height and turf penetration resistance can also be used for diagnostic purposes especially when poor or non-uniform observations are made for appearance or performance characteristics. Turf penetration resistance is likely to be affected by soil moisture content, and both parameters should ideally be determined at the same time to facilitate interpretation of the results. Management decisions such as irrigation scheduling, soil de-compaction operations, mower settings and cutting frequency can be guided by the results of these tests.

The speed at which a cricket ball rolls on a field can affect the rate of scoring and the liveliness of a game. This characteristic can be measured with a stimpmeter, which was initially developed for use on golf courses (Nikolai, 2005). The instrument measures ball roll distance on the turf grass using a ramp method to standardize the speed of ball release. Stimpmeter measurements are routinely made on golf greens and serve to guide management decisions as well as for promotion of the facilities. Ball roll distance determined with a stimpmeter is sometimes referred to as ‘turf speed’ in the golf industry and results are quoted in feet, with readings generally in the range of below 7.5 (slow) to over 10.5 for the fastest greens (Nikolai, 2005). A similar principle has been used for the development of a modified instrument for use on soccer fields (FIFA, 2008) and specifications for an instrument for use on cricket fields have also been suggested (Lopez and Chinnery, 2009). Ball roll distance is likely to be affected by many field factors (Nikolai, 2005) and is expected to increase by lowering the grass height and by rolling (Kopec et al., 2007), but this may occur at the expense of turf quality (Hartwiger et al., 2001). Ball roll distance can be reduced with increased nitrogen fertilization (McCullough et al., 2006) probably due to increased shoot growth and wider leaves that can lead to increased ball roll resistance.

In this study, one or more parameters were determined using a particular field sampling pattern on cricket outfields selected for use during ICC Cricket World Cup 2007. The main objective was to develop a system to achieve a thorough sampling of field characteristics on the cricket outfield for generating quantitative data that will be useful in uniformity testing and for making comparisons across cricket outfields. It is envisaged that such a system can be useful across the cricketing world for providing objective field assessments and ratings that can serve to guide and reward grounds staff based on clearly defined standards. Field characteristics such as outfield hardness and traction are important considerations in relation to player safety, but these aspects were not determined in the current study since the focus was on field performance in relation to turf growth and ball behaviour. Using defined methods and the selected locations for measurements, the optimum number of replications needed for each parameter was investigated along with possible correlations between parameters within and across outfields.

METHODS

Measurements were made on cricket grounds selected for practice or tournament events across the Caribbean Region in relation to Cricket World Cup 2007, and were completed in 2006 during the period of 4-8 months prior to the start of the competition. Each field was divided into 4 sectors (north, south, east and west) and 3 circular regions (inner, middle and boundary), and there were six sample positions in each sector: 1 near the pitch (inner region), 2 midway towards the boundaries (midway region) and 3 on the outer ring (boundary region) of the field (Figure 1). One or more of the following determinations were made at each of the 24 locations on the selected fields: soil moisture content, grass height, turf penetration resistance, chlorophyll index and ball roll distance. Measurements began in the inner region and proceeded in a clockwise direction within each sector, starting with the eastern sector and proceeding clockwise to the northern sector (Figure 1). In order to investigate the optimum number of replications needed for each parameter, the order in which replications were considered was as follows: 8 replications (4 inner and 4 boundary locations), 12 replications (add 4 midway locations), 16 replications (add 4 more boundary locations), 20 replications (add 4 more midway locations), 24 replications (add 4 more boundary locations).

Volumetric soil moisture content (%) was determined using a soil moisture probe (model EC5, Decagon Devices Inc., USA). The probe was inserted vertically to its full depth (5cm) into the outfield sand and one soil moisture content reading was taken per sample location. Grass height (mm) was determined using the rising disc technique (New Zealand Sports Turf Institute, NZSTI, New Zealand) with the disc dropped from a height of 20cm, and one reading (mm) was taken per sample location. Turf penetration resistance (kPa) was determined using a golf-course, strain-gauge, soil compaction meter (Lang Penetrometer Inc. USA) with a cone tip 3mm high and 4.8mm (diameter) wide at the base. The 12.5cm long cylindrical needle of the instrument was pushed vertically at a slow and steady speed into the surface of the outfield sand and one reading was taken per sample location. Determinations of both volumetric soil moisture content and turf penetration resistance are likely to be affected by the length of the period required for completion of sampling. Field moisture conditions can change while measurements are in progress, which can also lead to changes in the values obtained for turf penetration resistance. All measurements across a field in this study were completed within 45 minutes.

Chlorophyll index (number) was determined with a chlorophyll index meter (FieldScout CM1000, Spectrum Technologies Inc. USA) at 6-8 points within a circle of 1-2m diameter on the field and the average was recorded as the reading for that particular location. The reading from this instrument is given as a dimensionless vegetation index calculated on the basis of sensor measurements of reflected red and infrared light wavelengths. The instrument was held about 1m from the turf and measurements were made under adequate sunlight levels as indicated by the onboard light sensor of the instrument.

Ball roll distance (m) was determined using a modified stimpmeter (Lopez and Chinnery, 2009) with 3 new standard cricket balls, and the average distance rolled was recorded for the sample location. All measurements were made in forward and reverse directions, towards and away from the middle of the active pitch in the centre of the field. The modified instrument operates in the same way as the golf stimpmeter (Nikolai, 2005, Radko, 1977), but the ball is released at an angle of 30° to the horizontal and rolls down a 1.5m rail ramp onto the turf with the seam oriented vertically in the direction of rolling. The translational speed of the ball as it exits the instrument was found to be 3.38 m s^{-1} (Lopez and Chinnery, 2009), which is comparable to 3.2 m s^{-1} found for the soccer stimpmeter (Kolitzus, 2003), and greater than 1.9 m s^{-1} found for the golf stimpmeter (Rist et al., 1999).

Diagrams were constructed using commonly available spreadsheet software (MS Excel) to show the spatial distribution of parameter values on each field. Data from within and across fields were subjected to correlation analysis using a statistical software package (SPSS). Standard deviation (SD), standard error (SE) and coefficient of variation (COV) were determined for each parameter in relation to the number of replications considered using a set order for the inclusion of replications from 8 to 24, as indicated above.

RESULTS AND DISCUSSION

Mean turf penetration resistance as measured by the Lang Penetrometer in the top soil layer (0-10cm) varied between 293 and 437 kPa and the mean COV was 14% on cricket outfields through out the region (Table 1). These values are within the acceptable range for penetration resistance on golf courses as measured by this instrument, which is given as 260 – 490kPa (Penetrometer readings 7.5 – 16.0) by the manufacturer. Somewhat higher values of penetration resistance have been reported on Bermuda grass golf courses and sports fields with values increasing due to traffic (Arrieta et al., 2009). At the time of measurements the surface sand layer had been recently constructed for all 4 fields sampled and it is likely that the penetration resistance would increase with time due to increased grass growth and soil compaction. Research is needed to determine the acceptable range of soil penetration resistance on cricket outfields taking into consideration the requirements for optimal turf performance and the safety of the players. Although mean field values were all within the 260 – 490kPa acceptable range, there were a few cases where individual measurements at some location clusters were above 490kPa and field de-compaction operations were recommended for such fields. Problem areas were identified to the grounds staff with the aid of visual mapping diagrams generated using the Excel spreadsheet software. In this study, penetration resistance was measured largely as a diagnostic tool to determine soil compaction levels in relation to grass growth and uniformity.

Repeat measurements of soil penetration resistance on two fields (SVR Antigua and TRE Jamaica) indicated a drop in penetration resistance following de-compaction operations (Table 1). The COV was as low as 6% for one field but was over 15% for 3 out of the 9 determinations made, indicating a wide variation in field uniformity across the region. The mean penetration resistance was not significantly affected as the number of replications per field increased from 8 to 24, however the standard error declined with increased number of replications and was predicted to reach a minimum (based on the fitted equation) after approximately 27 replications (Figure 2). The quadratic model provided an excellent description of the actual data obtained in this study as indicated by the coefficient of determination (R^2) value. We expect the decline in SE to approximate an asymptotic relationship as the number of replications increase, and the quadratic relationship is not expected to continue beyond the minimum. Only a very tiny proportion of the field is sampled with each determination of penetration resistance and it may be beneficial to use the average of 2 determinations (instead of a single determination) at each sampling location on the field, which can help to reduce the COV.

Mean values for chlorophyll index varied between 148 and 369 for the cricket outfields sampled and the average COV was 17% (Table 2). Values at individual locations reached a maximum of about 450 indicative of dense, green, healthy turf, while values below 150 were often obtained at locations with poor turf cover. Comparable values for canopy chlorophyll index have been reported for turf grasses including Bermuda grass cultivars (Jiang et al., 2004). Fertilizer application was recommended for field TRE Jamaica based on the low chlorophyll index values observed on 14 September. Significantly higher values were observed on a repeat visit to this field (21 November, Table 2), however the COV was very high and it appears that the fertilizer application was very recent and not very uniform. The COV was over 15% for 3 out of the 5 determinations made, and perhaps a larger number of readings (8-10 readings instead of 6-8) can be averaged at each field location in order to further reduce the COV. As was found for penetration resistance, the mean chlorophyll index was not significantly affected as the number of replications per field increased from 8 to 24, however the standard error declined and again was predicted to reach a minimum (based on the fitted equation) after approximately 27 replications (Figure 3).

The variation in mean grass height was relatively small for the fields sampled with a range of between 19 and 28mm and an average COV of only 10% (Table 3). These values for grass height are largely within the range (12.5 – 25mm) generally recommended for cricket outfields (Evans, 1991, Evans, 1996). The largest COV (14%) was observed for field TRE Jamaica on 21 November (Table 3) and this was likely due to recent and perhaps non-uniform fertilizer application on this field. Although the COV increased, the mean grass height was relatively unchanged on field TRE Jamaica for determinations made on 14 September and 21 November. Turf height across a field can vary depending on the type of mower, frequency of cutting, blade settings, and field characteristics such as evenness, surface hardness and the presence of weeds. However, one determination per field location appears to be sufficient for field characterization based on the generally low COV values obtained. As the number of replications per field increased from 8 to 24, the mean grass height was not significantly affected but the standard error declined as observed previously for other parameters and the fitted equation predicted a minimum after approximately 26 replications (Figure 4).

There was a wide variation in the results obtained for mean soil moisture content (v/v, %) for fields sampled across the region (Table 4). This parameter was measured on 4 fields with suspected problems in relation to soil moisture content, with GNS Grenada suspected of moisture deficiency due to difficulties with the irrigation system, while the other fields had drainage problems resulting in too much water in the root zone at the time of measurements. As suspected, the mean soil moisture content was relatively low for GNS Grenada, and was highest for TRE Jamaica (Table 4). The highest values at individual locations were observed for SVR Antigua and this field also had the highest COV (43%). When data for the fields with high moisture content were combined, there were strong negative correlations between soil moisture content and turf penetration resistance (Spearman's $r = -0.460$, $p < 0.01$) and between soil moisture content and grass height (Spearman's $r = -0.659$, $p < 0.01$). However, no consistent correlations were observed between the parameters studied on individual fields. As soil moisture content increases beyond a certain point, penetration resistance is expected to decrease due to increased fluidity of the surface sand, and mower wheels may then sink deeper into the surface resulting in a lower grass cutting height.

The average COV for soil moisture content on the sampled fields was very high (22%, Table 4) and it may be advantageous to use the average of 2 determinations (instead of a single determination) at each sampling location on the field, as recommended for penetration resistance. Only a very small proportion of the field in the immediate vicinity of the probe is sampled with each determination of soil moisture content. Large differences were observed between different sections of these fields for soil moisture content and it was possible to locate problem areas by using visual mapping diagrams as indicated for soil penetration resistance. As the number of replications per field increased from 8 to 24, the mean soil moisture content was not significantly affected but the standard error declined as observed previously and a minimum was predicted (based on the fitted equation) after approximately 23 replications (Figure 5).

Although ball roll distance was measured on sections of most fields, a complete data set was collected only for one field (SVR Antigua) on 8 September and an average value of 2.47m was obtained for 24 replications (Figure 6) with a COV of 5.8%. This average ball roll distance is relatively short, but this can be counteracted by having an increased number of replications per field to enhance coverage, which may not be absolutely necessary given the low COV observed. There was very little change in ball roll distance as the number of replications increased from 8 to 24 but the standard error declined, as noted for the other parameters, and the predicted minimum (based on the fitted equation) was reached after approximately 20 replications. These findings are similar to those reported previously for measurements of ball roll distance on another cricket field in the Caribbean region (Lopez and Chinnery, 2009). There was a highly significant negative correlation between ball roll distance and grass height for this field (Spearman's $r = -0.569$, $p < 0.01$), and a significant positive correlation between ball roll distance and turf penetration resistance (Spearman's $r = 0.502$, $p < 0.05$). A negative relationship between ball roll distance and grass height has been reported previously (Kopec et al., 2007) and can be explained by the increased frictional forces on the ball as it rolls through taller grass. A greater turf penetration resistance may indicate a more close-knit and perhaps firmer (less spongy) surface which can reduce the coarseness of the ball roll path resulting in lower resistance to ball rolling and greater ball roll distance.

CONCLUSIONS AND RECOMMENDATIONS

Appearance and performance characteristics of cricket outfields were determined in relation to turf growth and ball behaviour with the aim of developing a system for thorough field sampling and for making comparisons within and across fields. Very little benefit is likely to be derived by increasing the number of sampling locations per field much beyond 24 for the parameters studied. Suggestions have been made on possible ways to refine the sampling plan wherever COV was considered to be relatively high. Further research is recommended to determine whether the optimum range of soil penetration resistance on cricket fields should be similar to that recommended for other sports fields. The sampling pattern used appears to be adequate, and field means, variability, and possible correlations have been established for several parameters across a wide range of cricket fields in the region. This study has provided some useful information with regard to the development of field assessment standards for the Caribbean region.

ACKNOWLEDGEMENTS

Support and assistance during field measurements were provided by managers and grounds staff at the various grounds involved in Cricket World Cup 2007. Helpful suggestions were provided by Jeff Atherton, formerly of the University of the West Indies, Cave Hill, Barbados. This work was funded by research equipment grants from the University of the West Indies (Cave Hill Campus) and from Cricket World Cup 2007 West Indies Inc.

REFERENCES

ADAMS, W. A. & GIBBS, R. J. (1994) *Natural Turf for Sport and Amenity: Science and Practice,* UK, CAB International.

ARRIETA, C., BUSEY, P. & DAROUB, S. H. (2009) Goosegrass and Bermudagrass Competition under Compaction. *Agronomy Journal,* 101**,** 11-16.

EVANS, R. D. C. (1991) *Cricket grounds: The evolution, maintenance and construction of natural turf cricket tables and outfields*, The Sports Turf Research Institute, Bingley, UK.

EVANS, R. D. C. (1996) The Cricket Groundsman's Companion: A basic guide to the maintenance of cricket tables and outfields (pamphlet). The Sports Turf Research Institute, Bingley, UK.

EVERETT, R. & BAKER, S. (2007) Kensington Oval Barbados – A world class cricket venue. *Turfgrass Bulletin (April 2007),* 236**,** 8-11.

FIFA (2008) *FIFA Quality Concept: Handbook of test methods for football turf (January 2008 Edition),* Switzerland, FIFA.

HARTWIGER, C. E., PEACOCK, C. H., DIPAOLA, J. M. & CASSEL, D. K. (2001) Impact of light-weight rolling on putting green performance. *Crop Science,* 41**,** 1179–1184.

JIANG, Y., DUNCAN, R. R. & CARROW, R. N. (2004) Assessment of Low Light Tolerance of Seashore Paspalum and Bermudagrass. *Crop Science,* 44**,** 587-594.

KOLITZUS, H. J. (2003) Ball Roll Behavior: The Functional Relationship of the Ball Roll Distance and the Timing Gate Method: How to Calculate the Ball Roll Distance from Timing Gate Measurements. International Association for Sports Surface Sciences, http://www.isss.de/publications/ArtificialTurf/Ball_Roll_BehaviorKS.pdf.

KOPEC, D. M., WALWORTH, J. L., GILBERT, J. J., SOWER, G. M. & PESSARAKLI, M. (2007) 'SeaIsle 2000' Paspalum Putting Surface Response to Mowing Height and Nitrogen Fertilizer. *Agronomy Journal,* 99**,** 133–140.

LOPEZ, F. B. & CHINNERY, L. E. (2009) Development of a stimpmeter for cricket fields. *International Turfgrass Society Research Journal,* 11**,** 389-398.

MCCULLOUGH, P. E., LIU, H. B., MCCARTY, L. B. & TOLER, J. E. (2006) Bermudagrass putting green performance influenced by nitrogen and trinexapac-ethyl. *Hortscience,* 41**,** 802-804.

NIKOLAI, T. A. (2005) *The superintendent's guide to controlling putting green speed,* USA, John Wiley & Sons Inc.

RADKO, A. M. (1977) How fast are your greens? *USGA Green Section Record,* 15**,** 10-11.

RIST, A. M., KOCHER, M. F., STROUP, W. W., GAUSSOIN, R. E., GRISSO, R. D. & SHEARMAN, R. C. (1999) Golf ball deceleration measuring system to evaluate surface uniformity on golf course greens. *Crop Science,* 39**,** 741–745.

Table 1. Mean penetration resistance (kPa), standard deviation (SD) and coefficient of variation (COV, %) for cricket outfields sampled across the region.

Cricket Ground / Date	Mean	SD	COV
SVR Antigua, 8 Sep.	437	91.2	21
QPO Trinidad, 31 Oct.	428	71.2	17
BSJ St Lucia, 23 Nov.	402	34.4	9
TRE Jamaica, 14 Sep.	397	25.3	6
SAB Jamaica 13 Sep.	384	51.4	13
TRE Jamaica, 21 Nov.	366	46.6	13
SVR Antigua, 18 Nov.	356	75.3	21
GNS Grenada, 17 Nov.	308	29.8	10
KNO Barbados, 4 Sep.	293	43.1	15
Mean	374	52.0	14

Table 2. Mean chlorophyll index, standard deviation (SD) and coefficient of variation (COV, %) for cricket outfields sampled across the region.

Cricket Ground / Date	Mean	SD	COV%
SVR Antigua, 8 Sep.	369	54.0	15
BSJ St Lucia, 23 Nov.	329	55.1	17
TRE Jamaica, 21 Nov.	213	51.1	24
QPO Trinidad, 31 Oct.	182	16.9	9
TRE Jamaica, 14 Sep.	148	27.5	19
Mean	248	40.9	17

Table 3. Mean grass height (mm), standard deviation (SD) and coefficient of variation (COV, %) for cricket outfields sampled across the region.

Cricket Ground / Date	**Mean**	**SD**	**COV%**
QPO Trinidad, 31 Oct.	28	1.7	6
SVR Antigua, 8 Sep.	27	3.0	11
KNO Barbados, 4 Sep.	24	1.9	8
TRE Jamaica, 21 Nov.	23	3.1	14
TRE Jamaica, 14 Sep.	22	2.4	11
BSJ St Lucia, 23 Nov.	19	1.9	10
Mean	24	2.3	10

Table 4. Mean soil moisture content (v/v, %), standard deviation (SD) and coefficient of variation (COV, %) for cricket outfields sampled across the region.

Cricket Ground / Date	**Mean**	**SD**	**COV%**
TRE Jamaica, 21 Nov.	31	5.4	18
SVR Antigua, 18 Nov.	25	11.0	43
QPO Trinidad, 31 Oct.	18	2.9	16
GNS Grenada, 17 Nov.	11	1.4	12
Mean	21	5.2	22

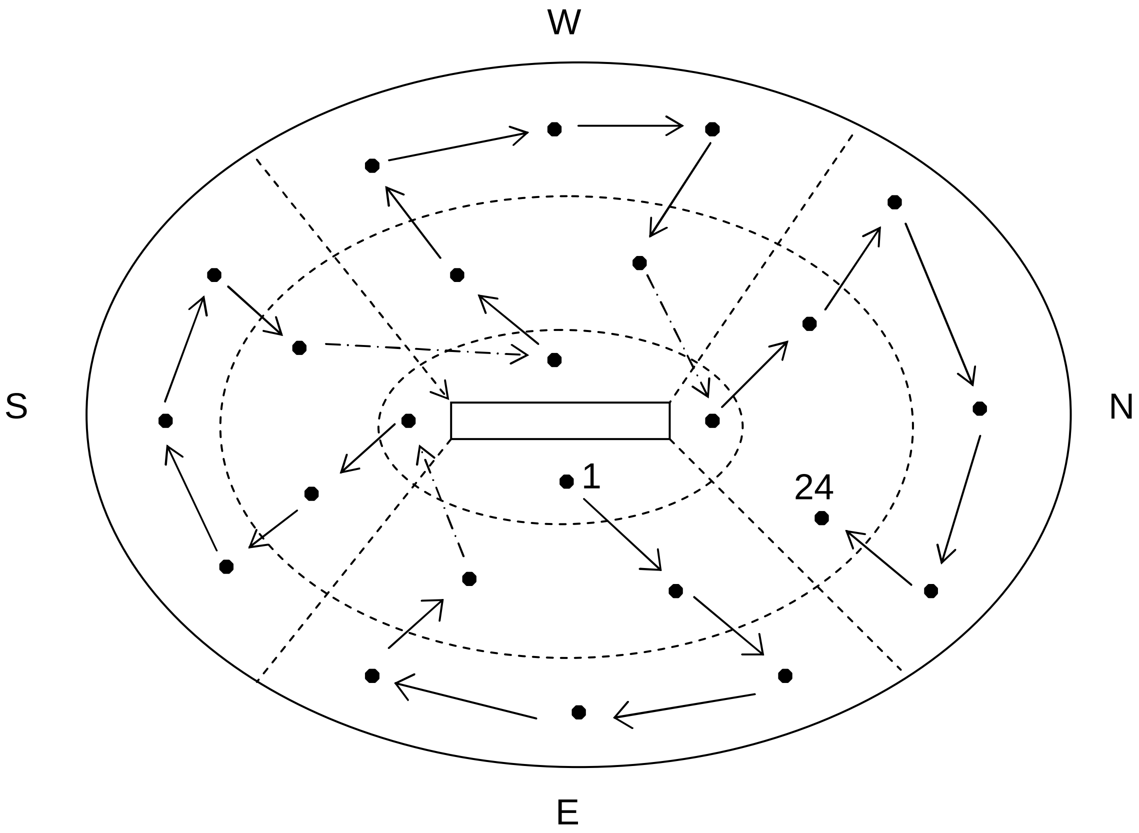

Figure 1. Diagram showing the locations of cricket outfield tests and the pathway followed during field sampling from location 1 to 24, starting in the Eastern (E) sector and ending in the northern (N) sector.

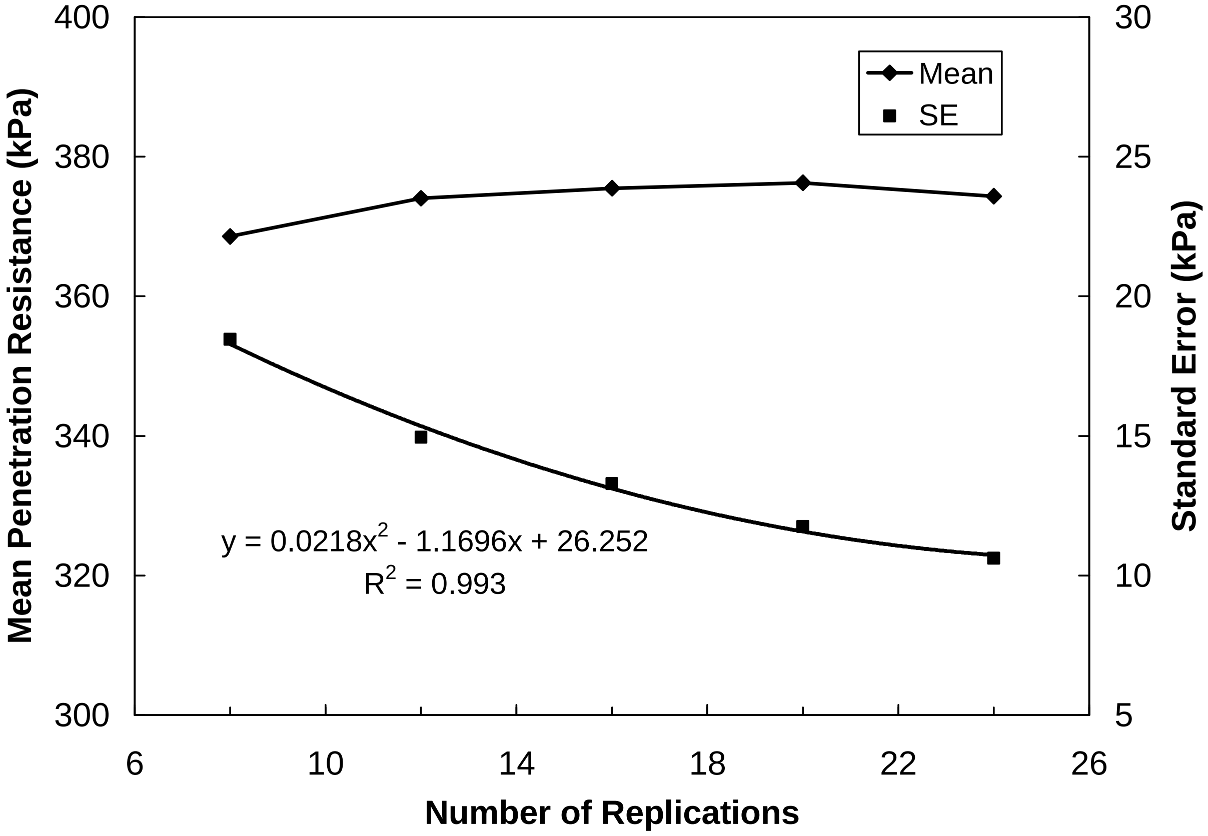

Figure 2. Mean penetration resistance (kPa) and standard error (SE) as affected by the number of replications on cricket outfields sampled across the region. Data were pooled for 9 fields and the overall average values are presented.

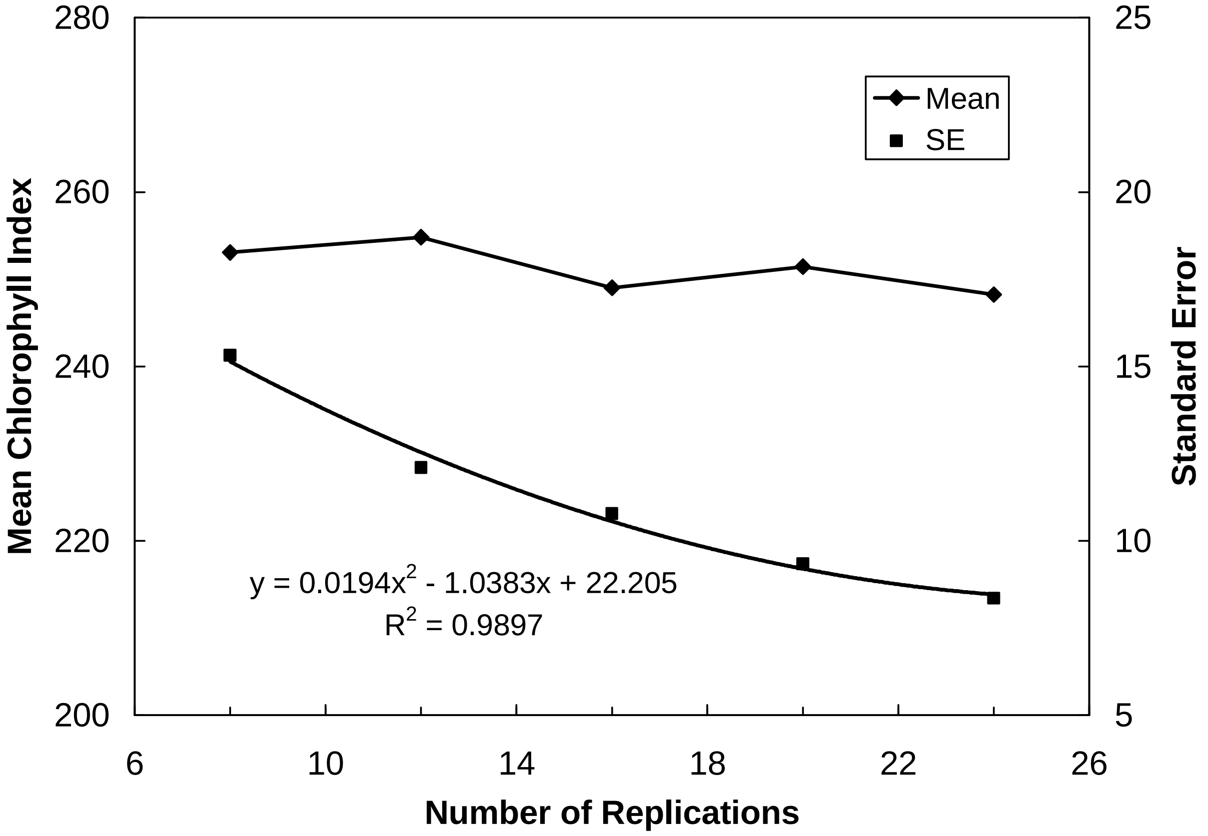

Figure 3. Mean chlorophyll index and standard error (SE) as affected by the number of replications on cricket outfields sampled across the region. Data were pooled for 5 fields and the overall average values are presented.

ISBN-13: 978-1-897911-34-1 Editors: P.R. Fleming and S.E.Forrester

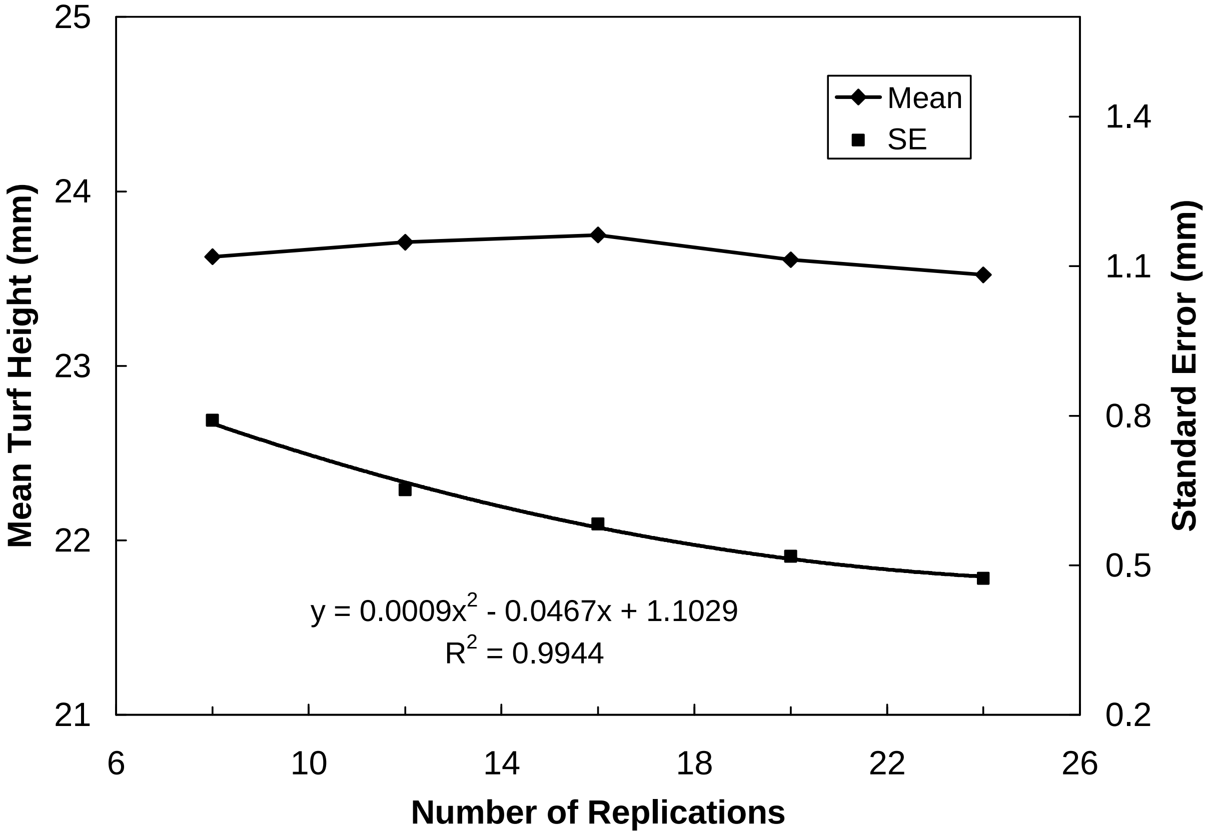

Figure 4. Mean turf height (mm) and standard error (SE) as affected by the number of replications on cricket outfields sampled across the region. Data were pooled for 6 fields and the overall average values are presented.

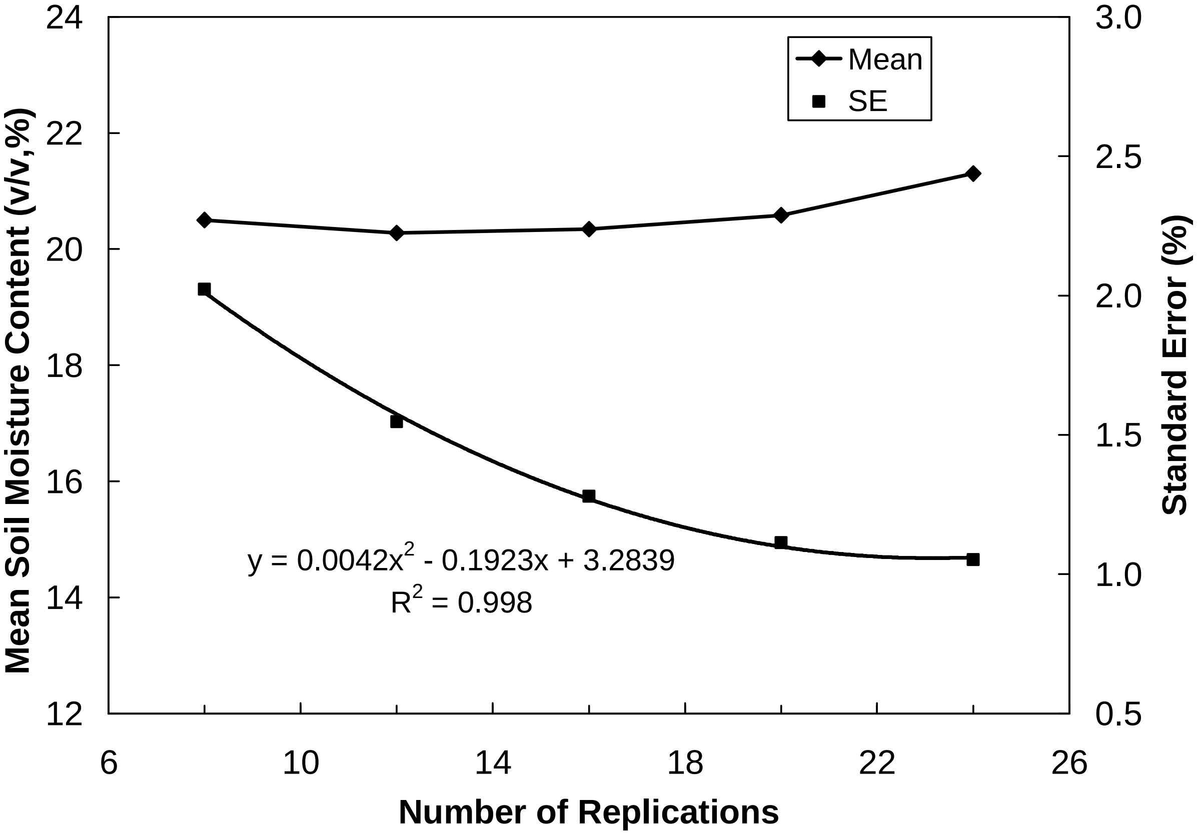

Figure 5. Mean soil moisture content (v/v, %) and standard error (SE) as affected by the number of replications on cricket outfields sampled across the region. Data were pooled for 4 fields and the overall average values are presented.

ISBN-13: 978-1-897911-34-1 Editors: P.R. Fleming and S.E.Forrester

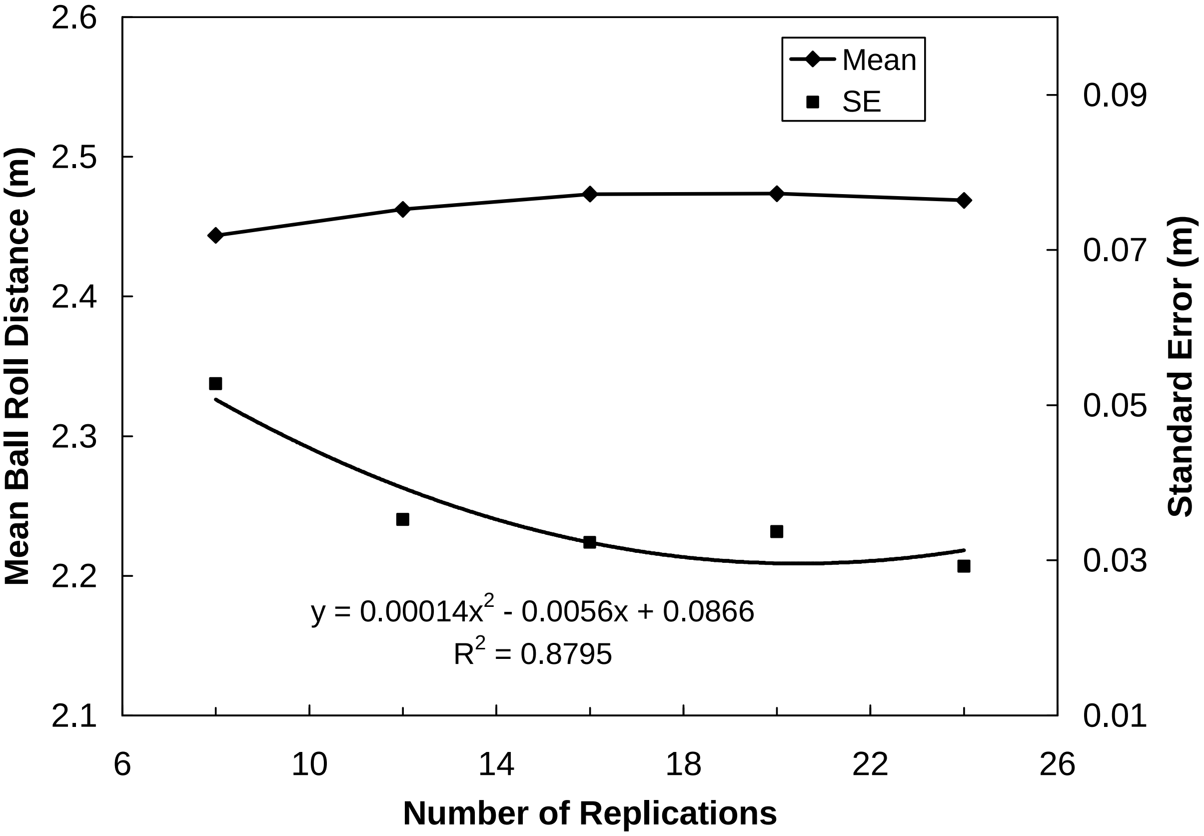

Figure 6. Mean ball roll distance (m) and standard error (SE) as affected by the number of replications on cricket outfield SVR Antigua determined on 8 September 2006.