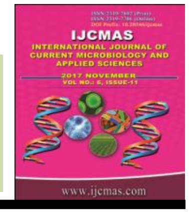
Int.J.Curr.Microbiol.App.Sci (2017) *6*(11): 1030-1036

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 11 (2017) pp. 1030-1036**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2017.611.120

Calibrating the Leaf Colour Chart for Nitrogen Management in Maize (*Zea mays* L.) under Irrigated Condition

Shivakumar[1], M.A. Basavanneppa[2*], B.G. Koppalkar[1], M.R. Umesh[1] and Ashok Kumar Gaddi[2]

[1]Department of Agronomy, University of Agricultural Sciences, Raichur, Karnataka, India
[2]Agricultural Research Station, Siruguppa- 583 121, Karnataka, India
Corresponding author

Keywords

Grain yield, Nitrogen management, Leaf colour chart and economics.

Article Info

Accepted:
10 September 2017
Available Online:
10 November 2017

A B S T R A C T

The field experimentwas conducted at Agricultural Research Station, Siruguppa, University of Agriculture Sciences, Raichur, Karnataka, during *kharif* 2016 to study the "Calibrating the leaf colour chart for maize (*Zea mays* L.) nitrogen management under irrigated condition" and to evaluate and establish LCC threshold values for saving fertilizer N and achieve higher grain yield. The experimental site was medium deep black soil. The experiment consists of ten treatments *viz*., T_1: N application at LCC threshold ≤ 1, $T_{2:}$ N application at LCC threshold ≤ 2, $T_{3:}$ N application at LCC threshold ≤ 3, T_4: N application at LCC threshold ≤ 4, T_5: N application at LCC threshold ≤ 4.5, T_6: N application at LCC threshold ≤ 5, T_7: N application at LCC threshold ≤ 5.5, T_8: N application at LCC threshold ≤ 6, T_9: RDN (190 kg ha^{-1}) and T_{10}: Absolute control. These treatments were replicated thrice in Randomized Complete Block Design (RCBD). Application of nitrogen fertilizer based on LCC threshold ≤ 5 recorded higher grain yield (8339 kg ha^{-1}), stover yield (10424 kg ha^{-1}) and harvest index (44.4%). Net returns (Rs. 80650) and B:C ratio (2.88) were recorded in N application at LCC threshold ≤ 5.

Introduction

Nutrient management has played a crucial role in achieving self-sufficiency in food grain production. The need for precise and responsive management of N fertilizer in Maize is compelling for both economic and environmental reasons. Static fertilizer recommendations based on average response lead to excessive fertilization in some years and inadequate fertilizers in years with high N losses. The uncertainty in optimum N rate poses risks for profit loses which is exacerbating by the asymmetric profit response of maize to N rates. The associated higher cost of under fertilization relative to over fertilization drives farmers to apply imbalanced rates. This uncertainty can be addressed by providing more accurate location and time specific recommendations that increase accuracy and reduce uncertainty.

The farmers generally use leaf colour as a visual and subjective indicator for N fertilizer need (Furuya, 1987). Since farmers generally prefer to keep leaves of the crop dark green, it leads to over application of fertilizers N resulting in low recovery efficiency. Thus, the spectral properties of leaves should be used in a more rational manner to guide need based fertilizer N applications. Further, in recent years many precision tools are being used in the nitrogen management especially in maize. Among these precision tools, leaf colour chart (LCC) is one and it was developed for rice and it is also suitable for maize as indicated by spectral reflectance measurement performance on rice (Balasubramanian *et al.*, 1999 and Balasubramanian *et al.*, 2002) and maize leaves (Witt *et al.*, 2005). LCC helps in promoting need based variable N application to rice crop based on soil N-supply and crop demand. It is an ideal tool to optimize N use, irrespective of the source of N applied (Balasubramanian, 1984 and Balasubramanian *et al.*, 2000).

Materials and Methods

The field test turned into carried out at Agriculture Research Station, Siruguppa, University of Agriculture Sciences, Raichur and is located at 76^{o}54" East longitude, 15^{o} 38" North Latitude and at an elevation of 380 m from MSL. The station is situated in Northern Dry zone (Region–II, Zone –3) of Karnataka. The experiment was laid out in Randomised Complete Block Design and soil was medium black and clay loam in texture, neutral in soil reaction (8.09) and low in electrical conductivity (0.26 dSm^{-1}).

The organic carbon content was 0.43 per cent and low in available N (225.80 kg ha^{-1}), medium in available phosphorus (24 kg P_2O_5 ha^{-1}) and high in available potassium (391 kg K_2O ha^{-1}). The hybrid maize NK 6240 used in the investigation and seeds were dibbled at 60 cm x 20 cm spacing. The N was managed through leaf colour chart thresholds. Irrespective of LCC levels, at basal 25 kg N full dose of P and K (75:37.5 kg P_2O_5 K_2O ha^{-1}) was applied to the soil in the form of single super phosphate and muriate of potash. For T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8 followed intermittent N applications as guided by LCC threshold 1, 2, 3, 4, 4.5, 5, 5.5 and 6, respectively. The subsequent N applications were carried out by matching the colour of youngest fully expanded top leaf of ten randomly selected maize plants from each plot at 15 days interval, starting from 15 days after sowing of maize till initiation of silking. If the greenness of 6 or more out of ten leaves is less than LCC threshold, top-dressing 20 per cent recommended dose of nitrogen. Whereas the greenness of 5 or more out of ten leaves is more than LCC threshold, no N was applied. During analysis colour of the leaf with LCC under shade of the body was matched visually with LCC and disease/insect free leaves of normal crop. Matching of the leaf was discontinued and no further N was applied after initiation of silking. Total quantity of nitrogen applied was based on observing LCC values. In RDN treatment the 50 per cent N is applied as basal and remaining half dose of nitrogen in the form of urea was top dressed at 30 and 45 days after sowing (DAS) (Table 1). Immediately after sowing Atrazine 50 per cent WP @ 1.00 kg a.i ha^{-1} was sprayed to control weeds. At 20 days after sowing bicycle weeder was used and hand weeding was done at 35 and 50 days after sowing to manage weeds.

Results and Discussion

Among N application primarily based on leaf colour chart thresholds, drastically advanced maize grain yield turned into recorded with N application at LCC threshold ≤ 5 (8339 kg ha^{-1}) and it was on par with N application at LCC threshold ≤ 5.5 (7799 kg ha^{-1}) and recommended nitrogen (7756 kg ha^{-1}) compared to rest of the treatments. Significantly lower maize grain yield was recorded under without fertilizer application (3725 kg ha^{-1}). Significantly higher amount of maize stover yield (10424 kg ha^{-1}) was registered under N application at LCC threshold ≤ 5 and significantly lower was recorded under without fertilizer application (5264 kg ha^{-1}) (Table 2).

Table.1 Quantity of fertilizers applied for different treatments (kg ha^{-1}) as influenced by leaf colour chart thresholds under irrigated condition

Treat-ments	Basal			15 DAS			30 DAS			45 DAS			60 DAS			75 DAS			Total			Saving of fertilizers over RDF		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
T_1	62	75	37.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	62	75	37.5	128	0	0
T_2	62	75	37.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	62	75	37.5	128	0	0
T_3	62	75	37.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	62	75	37.5	128	0	0
T_4	62	75	37.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	62	75	37.5	128	0	0
T_5	62	75	37.5	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	92	75	37.5	98	0	0
T_6	62	75	37.5	30	-	-	30	-	-	30	-	-	-	-	-	-	-	-	152	75	37.5	38	0	0
T_7	62	75	37.5	30	-	-	30	-	-	30	-	-	30	-	-	-	-	-	182	75	37.5	8	0	0
T_8	62	75	37.5	30	-	-	30	-	-	30	-	-	30	-	-	30	-	-	212	75	37.5	-22	0	0
T_9	94	75	37.5	24	-	-	24	-	-	24	-	-	24	-	-	-	-	-	190	75	37.5	0	0	0
T_{10}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0

T_1: N application at LCC threshold ≤ 1 T_2: N application at LCC threshold ≤ 2 T_3: N application at LCC threshold ≤ 3
T_4: N application at LCC threshold ≤ 4 T_5: N application at LCC threshold ≤ 4.5 T_6: N application at LCC threshold ≤ 5
T_7: N application at LCC threshold ≤ 5.5 T_8: N application at LCC threshold ≤ 6 T_9: Recommended nitrogen (190 kg ha^{-1})
T_{10}: Absolute control

Table.2 Grain yield, stover yield and harvest index of maize as influenced by N application based on leaf colour chart thresholds under irrigated condition

Treatments	No. of grains row^{-1}	Cob weight plant^{-1} (g)	Test weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
T1: N application at LCC threshold ≤ 1	26.9	181.0	31.7	5157	6652	43.7
T2: N application at LCC threshold ≤ 2	29.1	182.2	32.7	6104	7835	43.8
T3: N application at LCC threshold ≤ 3	29.9	183.0	32.9	6369	8191	43.7
T4: N application at LCC threshold ≤ 4	30.2	183.1	33.1	7289	9184	44.2
T5: N application at LCC threshold ≤ 4.5	30.4	187.0	33.6	7453	9316	44.4
T6: N application at LCC threshold ≤ 5	33.1	214.0	36.8	8339	10424	44.4
T7: N application at LCC threshold ≤ 5.5	32.4	209.6	36.6	7799	9827	44.2
T8: N application at LCC threshold ≤ 6	30.4	197.0	33.7	7504	9455	44.2
T9: Recommended nitrogen (190 kg ha^{-1})	31.8	206.0	35.9	7756	9696	44.4
T10: Absolute control	14.2	160.0	23.0	3725	5264	41.4
S.Em.±	0.9	5.6	1.0	**227**	**314**	**0.0**
C.D. (P=0.05)	2.6	16.6	3.0	**674**	**934**	**NS**

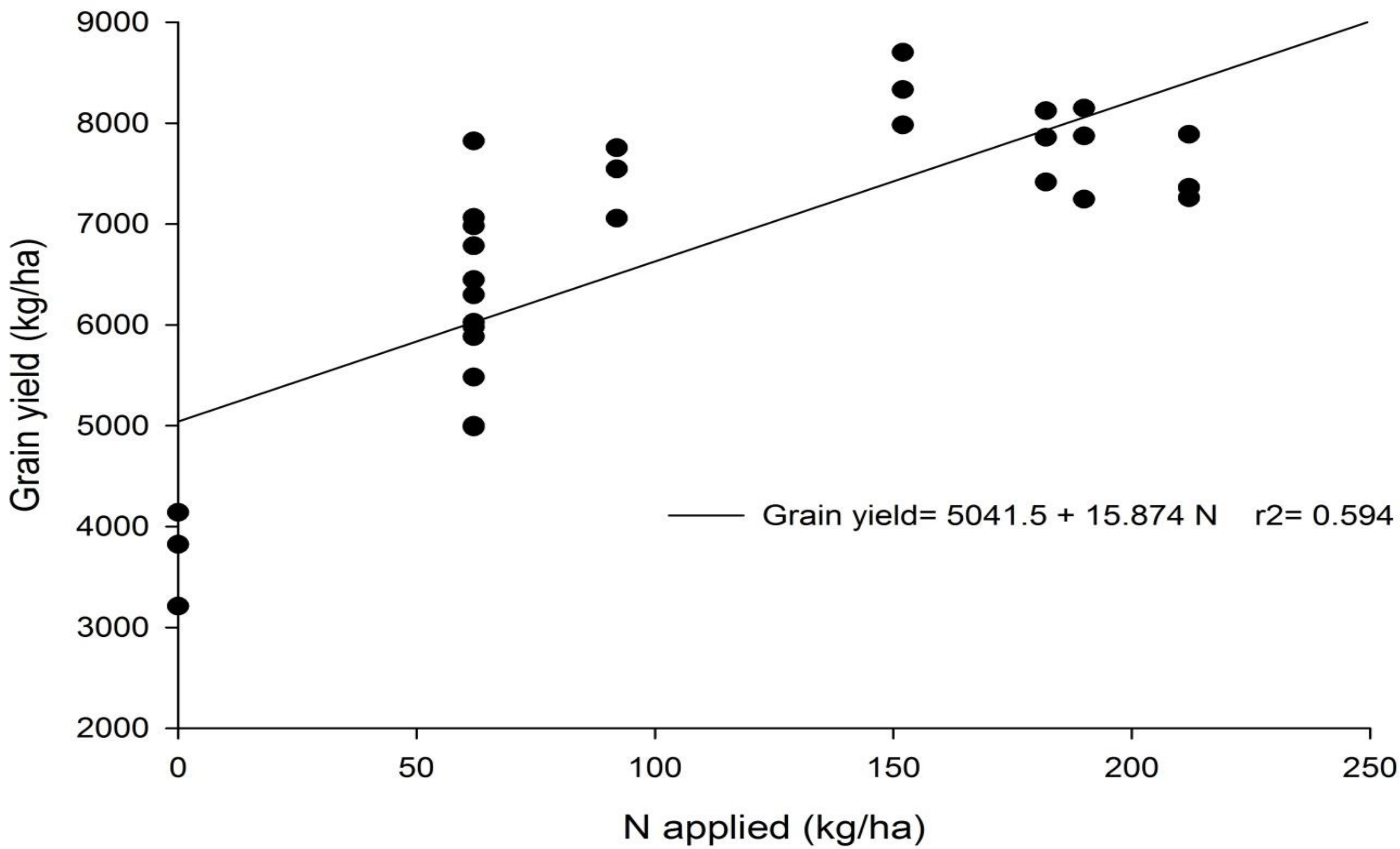
LCC: Leaf Colour Chart NS: Non significant

Table.3 Cost of cultivation, gross returns, net returns and B: C ratio of maize production as influenced by N application based on leaf colour chart thresholds under irrigated condition

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs.ha^{-1})	B:C ratio
T1: N application at LCC threshold ≤ 1	38921	76551	37630	1.97
T2: N application at LCC threshold ≤ 2	39221	90594	51374	2.31
T3: N application at LCC threshold ≤ 3	39281	94535	55255	2.41
T4: N application at LCC threshold ≤ 4	39551	108101	68550	2.73
T5: N application at LCC threshold ≤ 4.5	40642	110486	69844	2.72
T6: N application at LCC threshold ≤ 5	42975	123624	80650	2.88
T7: N application at LCC threshold ≤ 5.5	43826	115664	71838	2.64
T8: N application at LCC threshold ≤ 6	44797	111284	66487	2.48
T9: Recommended nitrogen (190 kg ha^{-1})	43290	114988	71697	2.66
T10: Absolute control	32410	55532	23122	1.71
S.Em.±			**3373**	**0.09**
C.D. (P=0.05)			**10022**	**0.25**

LCC: Leaf Colour Chart

Fig.1 Regression and correlations between grain yield (kg ha^{-1}) and N applied rate (kg ha^{-1}) as influenced by N management through leaf colour chart thresholds in maize under irrigated condition



The higher grain and stover yield obtained when N was managed at LCC threshold ≤ 5 was obviously due to favourable nutrition or balanced level of nutrient application during the crop growth stages. However, in LCC-1, 2, 3, and 4 the amount of N was less and plant suffer for want of N at critical stages of crop growth (4^{th} leaf, 8^{th} leaf stage, tasseling and silking) where N is most required at these stages as we seen from the uptake of N. This was further evidenced by positive relationship between N applied and grain yield (r^2= 0.59) (Fig. 1). Similarly, these results are in accordance with findings of Roland *et al.*, (2013) they reported that, LCC threshold 5 recorded substantially better grain (44 q ha^{-1}) and straw yield (70 ha^{-1}) of maize in comparison to LCC threshold at 4 and 3. Significantly higher growth and yield additives had been located with LCC < 5. These results were also in conformity with findings of Angadi *et al.*, (2002); Datturam and Shashidhar (2012); Sarnaik (2010); Mallikarjuna *et al.*, (2016) and Singh *et al.*, (2016). Harvest index indicates the percentage of dry matter partitioned and accumulated in the economic portion. In the present investigation higher harvest index (44.4%) was registered with N application at LCC threshold ≤ 5 as compared to other treatments (Table 2). Similar results were reported by Jayanthi *et al.*, (2007) where in the harvest index favourably increased with increasing N rates in LCC based nitrogen application.

The increased yield under N application at LCC threshold ≤ 5 resulted in improvement of economic returns of maize production. The higher gross returns and net returns was registered with N application at LCC threshold ≤ 5 (Rs. 1,23,624 ha^{-1} and Rs. 80,650 ha^{-1}, respectively) compared to rest of the treatments and it was followed by N application at LCC threshold ≤ 5.5 and recommended nitrogen. Relatively lower gross returns and net returns were recorded in absolute control (Rs. 55,532 ha^{-1} and 23,122 ha^{-1}, respectively) (Table 3). These higher gross and net returns were mainly attributed to higher grain and straw yield. The results are in line with the earlier findings of Sarnaik (2010) reported that higher gross returns (Rs. 74,795 ha^{-1}) and net returns (Rs. 58,257 ha^{-1}) was noticed with LCC-5 + 30 kg N ha^{-1} dressing^{-1} over all different remedy mixtures admitting controls in maize. These results were also in conformity with findings of Chandrasekhara (2009), Datturam and Shashidhar (2012) and Mathukia *et al.*, (2014).

Significantly higher benefit cost ratio (2.88) was recorded with N application at LCC threshold ≤ 5 compared to rest of the treatments and it was statistically on par withN application at LCC threshold ≤ 4 (2.73), N application at LCC threshold ≤ 4.5 (2.72), recommended nitrogen (2.66) and N application at LCC threshold ≤ 5.5 (2.64) (Table 3). Similar results were also reported by Maiti and Das (2006), Ravi *et al.*, *(*2007).

Thus, the study revealed that presently farmers are applying lower fertilizer than crop requirement and by application of N fertilizers based on leaf colour chart at threshold ≤ 5 was optimum to achieve higher yield, net returns, and increase the efficiency of applied fertilizers with a saving of 40 kg N ha^{-1} over recommended N for the region. Thus, LCC helps to economize N use besides reducing cost of maize production.

References

Angadi, V.V., S. Rajakumara, Ganajaxi., A.Y. Hugar, B. Basavaraj, S.V. Subbaiah, V. Balasubramanian, 2002. Determining the leaf colour chart threshold value for nitrogen management in rainfed rice. *International Rice Research Institute Notes*. 27(2): 34-35.

Balasubramanian, P., 1984. Nitrogen fertilization for short duration rice. *International Rice*

Research Institute Notes., 9: 29.

Balasubramanian, V., A.C. Morales, R.T. Cruz, and S. Abdulrachman, 1999. On farm adaptation of knowledge intensive nitrogen management technologies for rice systems. *Nutrient Cycling in Agro-Ecosystems.*, 53: 59-69.

Balasubramanian, V., A.C. Morales, R.T. Cruz, T.M. Thiyagarajan, R. Nagarajan, M. Babu, S. Abdulrachman, and L.H. Hai, 2000. Application of the chlorophyll meter (SPAD) technology for real-time N management in rice. A review, *International Rice Research Institute Notes.*, 251:4-8.

Balasubramanian, V., A.C. Morales, R. Torres, G. Gines, W. Collado, and E. Redona, 2002. Response of rice hybrid and an inbred variety to urea briquette deep placement in the Philippines. *Journal of Agricultural Research Manage.* 1: 50-60.

Chandrashekara, C.P. 2009. Resource management in sugarcane (*Saccharum officinarum* L.) through drip irrigation, fertigation, planting pattern, and LCC based N application and area - production estimation through remote sensing. *Ph.D Thesis*, University of Agricultural Sciences, Dharwad (India).

Datturam, K. and G.B. Shashidhar, 2012. Need-based nitrogen management using leaf colour chart in sweet corn genotypes (*Zea mays* L. *Saccharata*). *Karnataka Journal of Agricultural Sciences.*, 25(4): 557-608.

Furuya, S., 1987. Growth diagnosis of rice plants by means of leaf color. *Japan Agricultural Research.*, 20, 147-153.

Jayanthi, T., S.K. Gali, V.V. Angadi, and V.P. Chimmad, 2007. Effect of leaf colour chart based nitrogen management on growth and yield parameters of rainfed rice. *Karnataka Journal of Agricultural Sciences.*, 20(2): 272-275.

Maiti, D. and D.K. Das, 2006. Management of nitrogen through the use of leaf colour chart (LCC) and soil plant analysis development (SPAD) in wheat under irrigated ecosystem. *Archives of Agronomy and Soil Science.*, 52(1): 105-112.

Mallikarjuna Swamy, M.R. Umesh, N. Ananda, U.K. Shanwad, A. Amaregouda, and N. Manjunath, 2016. Precision nitrogen management for *rabi* sweet corn (*Zea mays saccharata* L.) through decision support tools. *Journal of Farm Science.*, 29(1):14-18.

Mathukia, R. K., R. Puja, and N.M. Dadhania, 2014, climate change adaptation: real time nitrogen management in maize (*Zea mays* L.) using leaf colour chart. *Current World Environment.*, 9(3):1028-1033.

Ravi, S., B. Chandrasekaran, and S. Ramesh, 2007. Exploitation of hybrid vigour in rice hybrid (*Oryza sativa* L.) through green manure and leaf colour chart (LCC) based N application. *Asian Journal of Plant Science.*, 6(2): 282-287.

Roland, J. B., C.Rowena, D.B. Marcovan, and G. Gabinete, 2013. Nutrient management decision tool for small-scale rice and maize farmers. *Computers and Electronics in Agriculture.*, 12: 22-28.

Sarnaik, P., 2010. Nitrogen management in hybrid maize through leaf colour chart, *M. Sc (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.

Singh, V., B. Amit, and P.S. Ajeet, 2016. Evaluation of leaf-colour chart for need-based nitrogen management in maize (*Zea mays* L.) grown under irrigated condition of Mollisols. *Indian Journal of Agronomy*, 61 (1): 47-52.

Witt, C., J.M., Pasuquin, R. Mutters, and R.J. Buresh. 2005. New leaf colour chart for effective nitrogen management in rice. *Better Crops*, 89(1): 36-39.

How to cite this article:

Shivakumar, M.A. Basavanneppa, B.G. Koppalkar, M.R. Umesh and Ashok Kumar Gaddi. 2017. Calibrating the Leaf Colour Chart for Nitrogen Management in Maize (*Zea mays* L.) under Irrigated Condition. *Int.J.Curr.Microbiol.App.Sci.* 6(11): 1030-1036.
doi: https://doi.org/10.20546/ijcmas.2017.611.120