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Original Research Article

PREPARATION OF FARMER'S FRIENDLY REAL TIME LEAF COLOUR CHART (RTLCC) FOR JUDICIOUS MANAGEMENT OF NITROGEN FERTILIZER IN RICE FIELD

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Abstract: Selection of proper dose of inorganic N fertilizer in relation to the growth stage of rice plant is given priority for effective field nutrient management. Farmers either follow typical leaf colour chart (LCC) or rely on conventional knowledge to apply N which often underscore the actual field nutrient necessity. The usual LCC, that are generally in practice, has only four green colour bands of different concentration and so does not represents the gradual change of leaf colour. Further reliance on farmer's conventional knowledge may sometime have proven unscientific and less prudent. In this contemplation the present real time leaf colour chart (RTLCC) which have a wide colour range enable the farmer to determine the required N dose more accurately and scientifically for effective field management .

Key Words:- Rice plant, Inorganic N fertilizer, real time leaf colour chart

Introduction

Plants build a remarkable diversity of pigment molecules, far more than animals they use light as their supply of energy (Vargas *et al.,* 2000). Plants make pigments to promote plunder for animals which pollinate flowers and scatter seeds (Oberrath *et al.,* 1999). Thus, pigments may have physiological and/or biological functions (Vargas *et al.,* 2000). Attraction of insects to plant is also been guided by the colour (Ashfaq *et al.,* 2005; Neog *et al.,* 2010). The chlorophylls, a and b, are the pigments of photosynthesis. Anthocyanins are water-soluble pigments produced via the flavonoid pathway in the cytoplasm of the coloured plant cell. Grossly, leaves change colour in relation to growth stages of plant and also in relation to seasons (Młodzińska, 2009; Milenković *et al.*2012; Aggrwal *et al.,* 2013). All leaves gradually lose chlorophyll during the growing season, and this loss accelerates before leaf fall (Coder, 2008). Under optimal conditions this process of chlorophyll loss is very orderly and allows the plants to re-absorb much of the nitrogen in the structure of the pigment molecule (Netto *et al.,* 2004). Carotenoid pigments are also lost from the plastids during aging (Wei *et al.,* 2002). Leaves that turn red, is the result of the active synthesis of anthocyanin pigments just before the leaves fall from the trees. In general, anthocyanin and chlorophyll produce brownish colors. Anthocyanins and carotenoids produce orange hues (Młodzińska, 2009).

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Nitrogen is a major nutrient which endures the foliage development of rice plant (Sen *et al.*, 2011). Application of nitrogen is rice growth stage specific and judicious application helps rice foliage to grow. Lack of nitrogen obviously implies lower yields but excessive nitrogen can sometime also lead to lower plant growth quality and increased vulnerability to pests and diseases, apart from the waste of expensive fertilizers. This is the reason why well-nitrogen management is intended (Auearunyawat *et al.*, 2012).

One primary cause of high production cost in rice farming is the huge rate of application of N fertilizer. Though in most of the cases it depends on the conventional perception of the farmers. For this reason, such application in turn results in either over application or under application (Maiti *et al.*, 2004). Both of these cases lead to physiological stress to rice plant and thus in turn results in either low yield or environmental distress. Under this constrain one of the major steps for most effective application of N fertilizer is the application of N befitted to rice plant growth and the actual need of the plant (Hirel *et al.*, 2011).

Fig.1: A farmer is comparing the colour of a collected leaf with the conventional leaf colour chart.

Leaf Color Chart (LCC) is primarily used to assess the plant nitrogen (N) status. The color strips of LCC are fabricated with narrow veins resembling those of rice leaves having 'window' of different colour grades **(Fig.1).** Each window defines a level of N status. The LCC is composed of four or more panels each having different variations of color green. It is arranged in a ruler-shaped designed where the panels are arrayed horizontally from yellowish green to dark green.The available LCC has 5-6 colour grades. But such LCC imposes strict limitation for the use of N as it only offers few colours. In this backdrop it is better to prepare a more specific and wide colour band for the accurate selection of N dose for field application.

Materials and Methods

Biological sample: Change of leaf colour of rice cultivar *Swarna mashuri* (MTU 7029) is taken for observation. 10 rice leaves was selected randomly from each of the 10 disease-free rice plants (*i.e* no discoloration and/or deformation) in a field with uniform plant population from the village Jodupur, Malda (Latitude 24 degree 40 ' 20" N to 25 degree 32'08" N longitude 87 degree 45' 50" E to 88 degree 28'10" E). West Bengal, India, during *Kharif* season for three consecutive months at 7-day intervals. In a total 250 leaf sample of uniform length and breadth were collected. All the data was recorded on a XL sheet.

Portion of rice leaf used: leaves having uniform length and breadth and a sharp tip was considered for the experimentation.

HP scanner and image acquisition: It is a scanner as well as Photostat machine. It has a plane floor where objects were kept. The upper surface of scanner covers the object, and then the object was accordingly scanned.

Image processing: Most image processing programs are designed to start by loading an/many rice leaf/leaves on the plane floor of the HP scanner. The images were processed by using the software Photoshop in the computer. Then these images, in consideration of necessity, were cropped and designed in a regular shape (100x635) by the software Microsoft Office 2010. After collection of the data at 10 days intervals from days after seedling (DAS) Among 250 scanned leaves colour most common coloured leaves are selected.

Picture acquisition: Camera is equipped with a sensor which records and stores both still or dynamic images. The digital camera has a more complex storage system having electronic storage device system. In this camera image-sensor chip is used to capture the image. This image-sensor chip with acquired picture was set to a computer; the picture was cropped and designed accordingly in a regular shape (100x635) by using the software Microsoft Office 2010.

Generation of real time leaf colour chart (RTLCC): The colour chart describes a wide array of different range of colour; from green to yellow colour range. The picture of the tip of the plant was taken and accordingly arranged. During preparation of LCC the (RYB) basic colour combination was also considered. The RYB (Red Yellow Blue) values were analyzed to achieve maximum correlation with the true chlorophyll status of plants. The advantage of using a portable scanner over a digital camera is the reduced effect of variation in lighting conditions on the images.

Natural real time leaf colour chart (N-RTLCC): The processed picture that was prepared from the collected leaf at 10-day interval was arranged accordingly. The leaf from earlier growth stage of paddy is more greenish in colour while that of from the late growth stage is yellowish in colour **(Fig.2).**

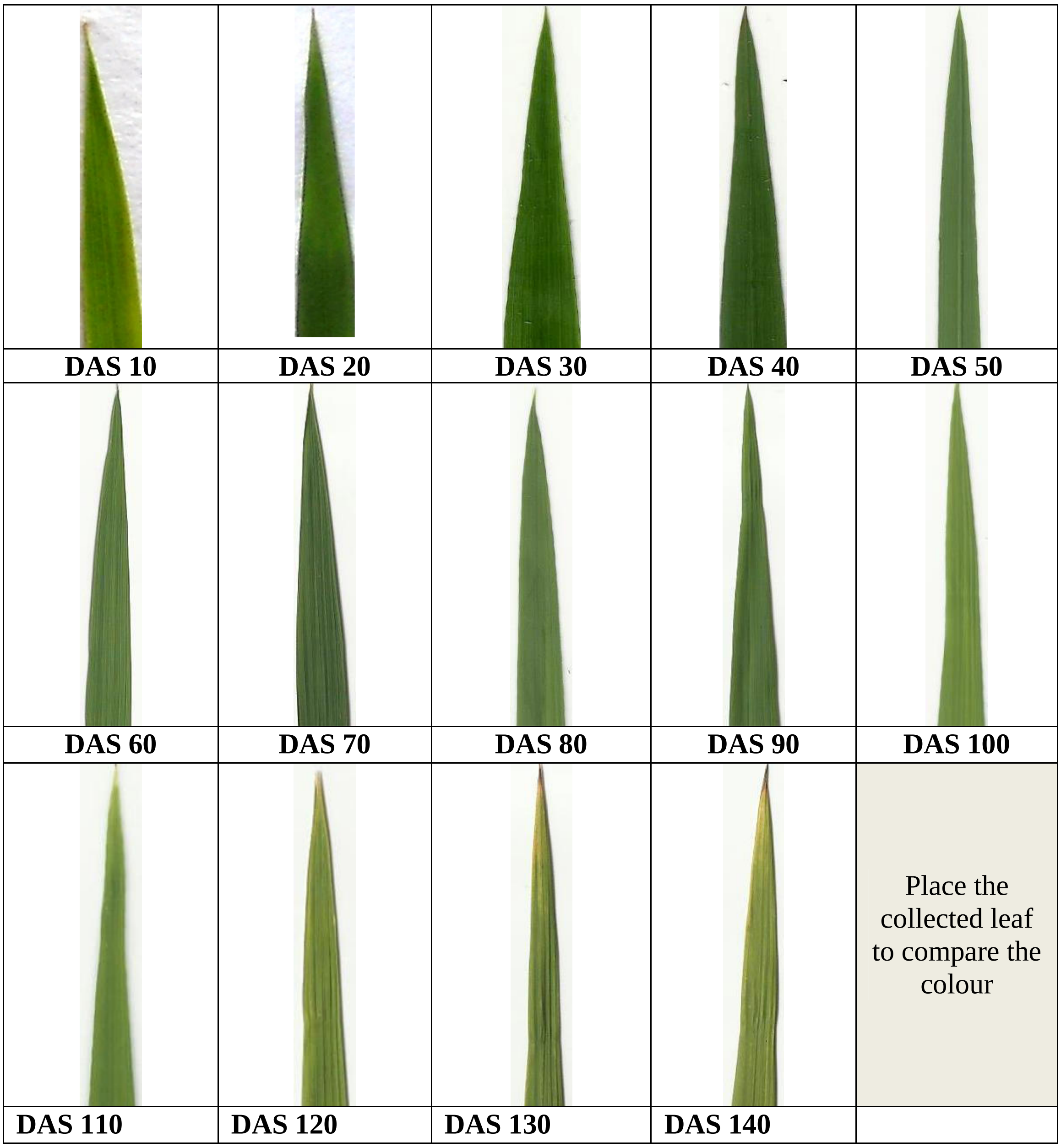


Fig.2: Natural real time leaf colour chart (N-RTLCC) showing different colour range.

Simulated real time leaf colour chart (S-RTLCC): The colour of the leaf during growth stages changes from green to yellow. A wide range of colour was prepared after mixing green and yellow colour of different ranges. The first and last colour box is absolute green (100%) and yellow (100%) respectively. To generate each colour box, starting from absolute yellow, 5% yellow colour was added manually to green colour, properly mixed, socked on a absorbent paper and accordingly photograph was taken. The naming of each colour box was made in consideration to the percentage of the respective colour **(Fig.3).**

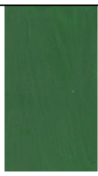
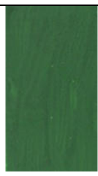
Place the collected leaf to compare the colour				
	5Y95G	**10Y90G**	**15Y85G**	**20Y80G**
				
25Y75G	**30Y70G**	**35Y65G**	**40Y60G**	**45Y55G**
				
50Y50G	**55Y45G**	**60Y40G**	**65Y35G**	**70Y30G**
				
75Y25G	**80Y20G**	**85Y15G**	**90Y10G**	**95Y5G**

Fig.3: Simulated real time leaf colour chart (S-RTLCC) showing different colour range.

Results and Discussion:-*Gross observation on leaf colour change:* A range of colour grade from vegetative stage to the yellow maturing stage of rice leaf was noted. At the tender age the leaf is green but as the leaf matures it turns yellow.

Basic component of RTLCC: The standard version consists of fifteen color green variations rated as four for yellowish green to eighteen for the dark green. It is made of pitch board and is one inches long. The strips are textured resembling as of the real rice leaf. The leaf colour chart (LCC) i.e.19 graded from 5% yellow 95% green to 95% green5% yellow has made. There is a 5% interval between two colour grades. The LCC is used for matching its colour with the growth stages rice leaf colour. ‘Y’ and “G’ represents the proportion of the respective colour in the colour mixture. Naming of a particular colour grade was done in consideration of the proportion (%) of the particular colour this colour matching can detects either it has need nitrogen fertilizer or not.

Superiority of RTLCC over LCC: RTLCC has some basic feature of superiority over LCC with, to analysis the rice leaf colour.

In consideration of the choice of colour grade: Each colour grade represents a proportional mixture of green and yellow colour. Rice leaf that was collected at 10 days after seedling transplantation (10 DAS) matches with 80Y20G (80%yellow and 20%green) colour of S-RTLCC. The entire subsequent colour grade with the addition of yellow colour and concurrent deduction of green colour. Similarly leaf collected at 20 DAS showed consonance with 50Y50G colour of S-RTLCC. The DAS 30 rice leaf colour matches with 40Y60G colour. 40 DAS rice leaf colour matches with 45Y55G. The 50 DAS rice leaf colour matches with 35Y65G. The 60 DAS rice leaf colour matches with 30Y70G colour. The 70 DAS rice leaf colour matches with 25Y75G colour. The 80 DAS rice leaf colour matches 25Y75G colour of LCC. The 90 DAS rice leaf colour matches with 35Y65G colour. The 100 DAS rice leaf colour matches with 75Y25G colour. The 110 DAS rice leaf colour of LCI matches with 85Y15G colour.

In consideration of applicability of colour grade: This colour chart consists of many shades of leaf colour from light green to dark green so it has wide application. It is used by cutting the sample leaf out and compare leaf colour with the colour in the chart. The chart will give a range of nitrogen quantity possible in that leaf. This is the easiest and also the least time consuming method and it is very suitable for small scale farmers. The RTLCC is an easy-to-use and inexpensive diagnostic tool for monitoring the relative greenness of a rice leaf as an indicator of the plant N status. The N status of rice is manifested on the greenness of its leaves. The rice's demand for nitrogen varies on its growing period thus assessment and monitoring of the required N content must be done periodically. RTLCC is basically a guide to supply the necessary N fertilizer for the optimal N content which is very necessary in achieving maximum yield. For the easy use of RTLCC the following guideline is prepared for the farmers (**Fig 4)**:

i. Randomly select at least 10 disease-free rice plants or hills in a field with uniform plant population of same cultivar at regular time interval.
ii. Select the topmost fully expanded leaf from each hill or plant. Place the middle part of the leaf on a chart and compare the leaf color with the color panels of the RTLCC. Do not detach the leaf from plat or destroy it.
iii. Compare the leaf color with the chart colour under the shade of an umbrella as direct sunlight affects leaf color readings. It is desired that the same person should take RTLCC readings at the same time at regular time interval to avoid personal error.
iv. Score the average RTLCC reading for the selected leaves in relation to plant growth stages.

Fig. 4: Mode of assessment of RTLCC in the farmers field (a) the rice field (b) selection of leaf (c) assessment of leaf greenness.

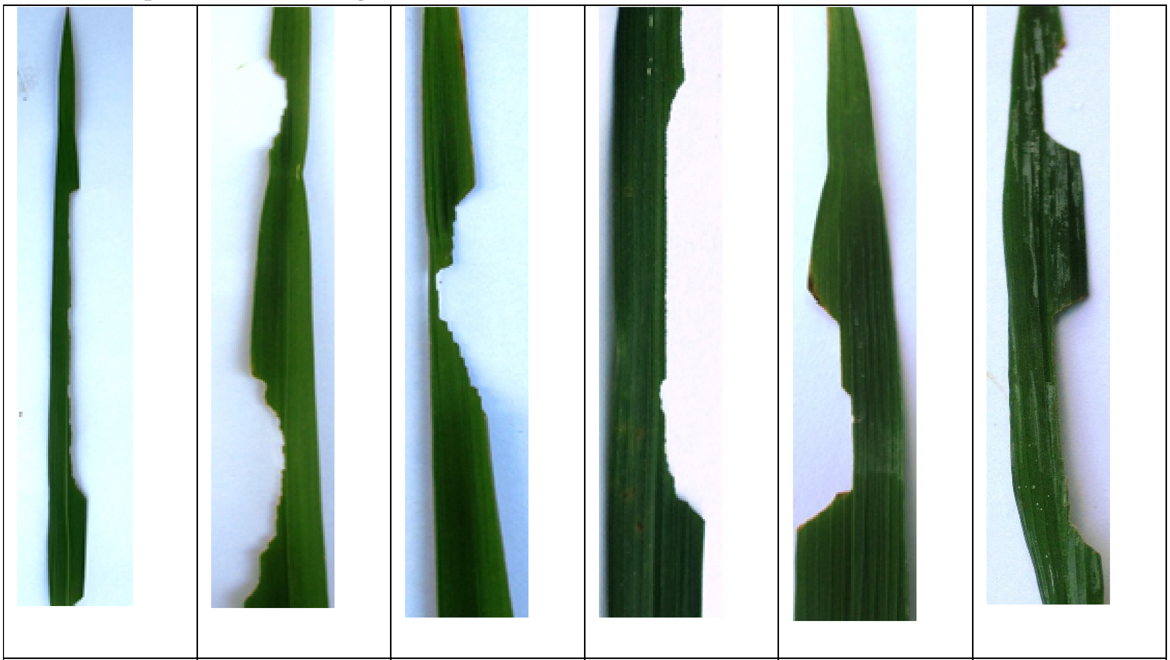
In consideration to survey insect pest attack(Fig. 5) : Following the periodic survey in rice field and simultaneous collection of rice leaf in relation to different growth stages a descriptive real time leaf colour chart (RTLCC) was prepared. Such RTLCC can be compared with the actual field data to detect the nutrient level of rice plant at different growth stages and to prepare the pest calendar. In general herbivorous insect pest favor deep green coloured leaves. RTLCC helps to detect that the condition of rice plant growth, health and insect pest attack. Stem borers, leaf folders and white backed plant hopper were observed as the major insect pests in the District Malda. Leaf colour that was favoured by the insect pests, the growth stage of rice plant at which maximum attack of the respective insect was noted and the gross impact on yield due to pest attack was noted in the table 1.

Insect pests	Growth stage of rice plant	Negative effect on yield	Extent of loss (%)	Grade of favourable leaf colour for insect attack
Stem Borers (SB)	From tillering stage towards deep green coloured leaf.	+++	5-65	
Leaf folder (LF)	Fleshy vegetative stage or aged nursery.	++	6-52	
Brown plant hopper (BPH) and leaf hopper (LH)	Increased with the increase of nitrogen application	++++	5-85	
gall midge (GM)	Tillering and stunted growth of the plants.	++	2-37	

(+, effective;++, more effective; +++, most effective; ++++, highly effective)

Table 1: Descriptive table showing major insect pests of Malda district.

The maximum range of insect pest attack on rice plant was noted at DAS 40. In consideration of GM attack, rice growth stage from DAS70 to DAS80 is more crucial. The colour of the rice leaf for the particular growth stage wad 45Y55G and 25Y85G respectively. Plants without N application are yellowish. Nitrogen deficiency is confirmed when the RTLCC reading is panels 99%yellow1%green. At lower rate of applied field N, the corresponding simulated colour in the card looks pale, while at higher N rates the plants look dark developed and the canopy is closed. The RTLCC reading is between panels 3 and 4, which is the critical range for most transplanted rice. In plants with a high N rate, leaves are dark green. Leaf color is darker than the LCC panel no 30Y70G indicating a surplus of fertilizer N.



Das 40	DAS 50	DAS 60	DAS 40	DAS 80	DAS 90

Fig.5: Extent of leaf damage by leaf hopper (LH) at different growth stage.

Discussion:-

Available leaf colour chart designed by International Rice Research Institute (IRRI) have only six colour options and Bangladesh Rice Research Institute (BRRI) have only four colour options but in the present RTLCC has 19 colour options. Application of RTLCC is low in cost (Rashid *et al*., 2007; Tabar , 2013). Kumar (2011) has noted that periodic monitoring of leaf colour using leaf colour chart is very effective for nitrogen management in farm. Use of leaf colour chart is recommended in Bangladesh, Pakistan (Gupta *et al*., 2007). But most of card has few colour options (Gupta *et al*., 2007). The suggested present real time leaf colour char (RTLCC) is more elaborative and descriptive in this respect. For this reason adoption of RTLCC improves the application of inorganic N to the field. It's applicability to other crops is also insurmountable since the leaf color chart adopted as standard in this application is only applied to rice (Witt *et al*., 2005; Timsina *et al*., 2001). The process is non-destructive as it does not include any biochemical test or detaching the leaf from the canopy. Multi-user functionality of this approach is also helpful as the application does not have the ability to distinguish one user from another which might pertain to a different rice population (Tabar, 2013). Leaf greenness is due to leaf chlorophyll content. For a more accurate setting to assess the leaf chlorophyll content, it is recommended to use a SPAD meter since it outputs a reading which could be easily compared to the reading of the application. But application of SPAD chlorophyll meter is expensive and expertization on this instrument is also necessary (Netto *et al*., 2004). For different species of crops use of alternative colour chart is suggested. As in rice RTLCC farmers have more option to compare leaf colour, it is better for the farmers to survey the rice leaf colour at 10-day interval from tillering up to about 5−10 days after panicle initiation. In general, farmers apply N whenever the leaves become more yellowish-green than a critical value that was determined by their conventional understanding by the farmers (Houshmandfar *et al*., 2011). The effective use of real-time N management requires the selection of an N dose and a critical threshold RTLCC color that ensures about 2 to 3 times rice plant growth stage specific N applications.

REFERENCES

1. Aggrwal, K.B., Ranjan, J.K., Rathore, S.S., Saxena, S.N. and Mishra, B.K. (2013). Changes in Physical and Biochemical Properties of Fenugreek (*Trigonella* sp. *L.*) Leaf During Different Growth Stages. *International Journal of Seed Spices, 3(1): 31-35.*
2. Ashfaq, M., Khan, R.A., Khan, M.A., Rasheed, F. and Hafeez, S. (2005). Insect Orientation to Various Color Lights in The Agricultural Biomes of Faisalabad. *Pakistan Entomology*, 27(1): 49- 52.
3. Auearunyawat, P., Kasetkasem, T., Wongmaneeroj, A., Nishihara, A. and Keinprasit, R. (2012). An Automatic Nitrogen Estimation Method in Sugarcane Leaves Using Image ProcessingTechniques. International Conference on Agricultural. *International Conference on Agricultural, Environment and Biological Sciences (ICAEBS'2012) May 26-27, 2012 Phuket.*
4. * Coder, K. D. (2008). Primer On Autumn Tree Leaf Colors, *Outreach Monograph WSFNR08*-28. 1-52.
5. Gupta, R. and Sayre, K. (2007). Paper Presented at InternationaL Workshop on Increasing Wheat Yield Potential, Cimmyt, Obregon, Mexico, 20–24 March 2006. *Journal of Agricultural Science,* 145: 207–214.
6. Hirel, B., Tétu, T., Lea, P. J. and Dubois, F. (2011). Improving Nitrogen Use Efficiency in Crops for Sustainable Agriculture. *Sustainability, 3:* 1452-1485.
7. Houshmandfar, A. and Kimaro, A. (2011). Calibrating the leaf colour chart for rice nitrogen management in Northern Iran. *African journal for Agricultural research*, 6(11): 2627-2633.
8. Maiti, D., Das, D.K., Karak, T. and Banerjee, M. (2004). Management of Nitrogen Through the Use of Leaf Color Chart (LCC) and Soil Plant Analysis Development (SPAD) or Chlorophyll Meter in Rice Under Irrigated Ecosystem. *The Scientific World Journal*, 4: 838–846.
9. Mathukia, R.K., Gajera, K.D., and Mathukia, P.R. (2014). Validation of Leaf Colour Chart For Real Time Nitrogen Management in Wheat. *Journal of Dynamics in Agricultural Research,* 1(1): 1-4.
10. Milenković, S.M., Zvezdanović, J. B., Anđelković, T.D., Marković, D. Z. (2012). The Identification of Chlorophyll and Its Derivatives in The Pigment Mixtures: HPLC-Chromatography, Visible and Mass Spectroscopy Studies. *Advanced Technologies*, 1(1): 16-24*.
11. Mlodzinska, E. (2009). Survey of Plant Pigments: Molecular and Environmental Determinants of Plant Colors. *Acta Biologica Cracoviensia Series Botanica*, 51/1: 7–16.
12. Neog, K., Unni, B. And Ahmed, G., (2010). Studies on the Influence of the Host Plants and Effect of Chemical Stumulants on the Feeding Behaviour in the Muga Silkworm, *Antheraea assamensis*. *Journal of Insect Science*, 11(133): 1-16.
13. * Netto, A.T., Campostrini, E., Oliveira, J.G.D., Ricardo Smith, R.E. B. (2005). Photosynthetic Pigments, Nitrogen, Chlorophyll a Fluorescence and SPAD-502 Readings in Coffee Leaves. *Scientia Horticulturae*, 104: 199–209.
14. Oberrath, R. and Gaese, k. (1999). Floral Color Change and the Attraction of Insect

Pollinators in Lungwort (*Pulmonaria collina*). *Oecologia*, 212(3): 383-391.

15. * Rashid, M.H., Khanand, M.A. H., Alam, M.M. (2007). The Family Approach for Scaling Out of Leaf Colour Chart Based Nitrogen Management in Rice. *Journal of Agriculture & Rural Development*, 5(1&2): 36-42.
16. Sen, A., Srivastava, V.K., Singh, M.K., Singh, R.K., Kumar, S. (2011). Leaf Colour Chart vis-a-vis Nitrogen Management in Different Rice Genotypes. *American Journal of Plant Sciences*, 2: 223-236.
17. Tabar, Y.S. (2013). Evaluation Use Leaf Color Chart in Rice For Nitrogen Management. *Scientia Agriculturae*, 3 (3): 66-69*.
18. Timsina, J. and Connor, D.J. (2001). Productivity and Management of Rice-Wheat Cropping Systems: Issues and Challenges. *Field Crops Research*, 69: 93-132.
19. Vargas, F.D., Jiménez, A.R. and López O. (2000). Natural Pigments: Carotenoids, Anthocyanins, and Betalains — Characteristics, Biosynthesis, Processing, and Stability. *Critical Reviews in Food Science and Nutrition*, 40(3): 173–289.
20. * Wei, Y.C., Lain, P.C., Jun, D., Zhu, L.G., Zhu, C.Y. (2002). Responses of Chlorophyll Fluorescence and Carotenoids Biosynthesis of High Light Stress Leaves at Different Leaf Position. *Acta Botanica Sinica*, 44(11): 1303-1308.
21. Witt, C., Pasuquin, J.M.C.A., Mutters, R., and Buresh R.J. (2005). New Leaf Color Chart for Effective Nitrogen Management in Rice. *Better Crops*, 1(89): 36-39.

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