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ESTABLISHING DISTINCTIVENESS AMONG RICE (*Oryza sativa*L.) VARIETIES BASED ON DUS DESCRIPTORS

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ABSTRACT

Sixty one extant varieties of rice (Oryza sativa L.) belonging to non-basmati and basmati group were characterized based on fifty-five morphological descriptors at different stages of plant growth. One of the major objective of cultivar characterization is to separate the varieties in to groups and then to identify them individually. To achieve the same, the varieties of the present study were singled out using a combination of grouping characters and essential characters as listed in DUS guidelines. Out of fifty five morphological descriptors studied, six characteristics were found monomorphic, nine were dimorphic and rest forty characteristics were found polymorphic in state of expression. Further the cultivars in the present study showed overlapping of descriptor expression which indicates insufficiency of morphological descriptors for assessment of distinctiveness or non-obviousness. The assessment of descriptor utility revealed that for traits involving anthocyanin coloration and pubescence, the state of expression needs to be modified from the existing one to only presence or absence of these traits.

Keywords: Essential Characteristics, Grouping Characteristics, Morphological Characterization, Rice

I INTRODUCTION

Cultivated rice (*Oryza sativa* L.) belongs to family Poaceae, at present sustains two thirds of the world's population. Rice is a rich source of carbohydrate and protein and provides vitamin, minerals and fiber. It provides 21% of the human per capita energy, and 15% of protein globally (FAO).India being one of the secondary centers of origin of rice (*Oryza sativa* L.) diversity is blessed with rich diversity of around 120,000 accessions of landraces, farmer's varieties and wild relatives [1].Intellectual Property Rights (IPR) system was internationalized in 1887 by the enactment of Paris Convention. However, agriculture was kept out of the purview of this system. Arguments specifically on Plant Breeders' Rights (PBRs) were made in the first quarter of the 20th Century from Netherlands

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(1919) [2] and USA (1931) [3]. First independent and complete IPR statue for plant varieties was passed in Netherlands in 1941, which came to be known as Plant Breeders' Decree (PBD). Nevertheless, this process got the required impetus through the UPOV (Union pour la Protection des ObtentionsVegetales) [4] convention in 1961 and later through the introduction of IPRs in agriculture under TRIPs through GATT (General Agreement on Trade and Tariff) in 1991. The GATT was transformed into permanent World Trade Organization (WTO) in 1994. Under TRIPs, it was made necessary to have some form of IPRs for plants either as patent or an effective *sui-generis* system such as PBRs. India ratified the agreement on TRIPs and the Presidential Ordinance was issued in 1994 amending the Indian Patent Act of 1970 and extending it to include agriculture; and also permitting patenting of products. The Bill on IPR was passed in 2001 as "Protection of Plant Varieties and Farmers' Rights Act" (PPV & FRA) 2001, which envisages that the new and notified/extant plant varieties will be registered and protected on the basis of their morphological characters i.e. Distinctness (D), Uniformity (U) and Stability (S) – [DUS]. There are about 700 released and notified varieties of rice (*Oryza sativa* L.) in India for which certain diagnostic features are known by the breeders and the same are followed for the purpose of seed certification procedure [5]. Thus, it has become necessary for all the organizations to document and characterize all the notified/extant varieties that are in active commerce in their territories. Under present study, therefore, sixty one varieties were characterized as per the National Test Guidelines.

II MATERIALS AND METHODS

Breeders' seed of 61 varietiesof rice (Table 1) belonging to non-basmati and basmati group was procured from the Breeder Seed Production unit of IARI New Delhi, and raised at the Seed Technology Farm in plot size of three rows with each row of four meter length. Row to row and plant-to-plant spacing was maintained at 30 x 20 cm during kharif 2012-13. The material was replicated thrice and all the recommended agronomic practices were followed to raise a good crop. Ten competitive plants were randomly selected from each genotype in each replication to record the data. National DUS Test Guidelines (2007) [6] were followed beginning from the trial layout to recording of the last field-related observation. As per the guidelines, fifty fivemorphological characters were recorded in rice material at different stages of plant growth.

Plants were examined for different morphological characters during different growth stages in the field. At booting stage, leaf and leaf sheath characters like anthocyanin coloration, its

Table1: List of genotypes/extant varieties of rice

S.No.	Genotype	S.No.	Genotype	S.No.	Genotype
1.	VIKRAMARYA	21.	PANT DHAN 12	41.	HMT PKV
2.	JAYA	22.	NIDHI	42.	GOVIND

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3.	PR 113	23.	SURAKSHA	43.	HEERA
4.	CSR 27	24.	SALIVAHANA	44.	VL DHAN 221
5.	KASTURI	25.	TARAORI BASMATI	45.	RASI
6.	PANT DHAN 11	26.	ANNADA	46.	SAMBHA MAHSURI
7.	VASUMATI	27.	CSR 10	47.	PR 106
8.	PUSA BASMATI 1	28.	VL DHAN 206	48.	PUSA 2-21
9.	KRANTHI	29.	VIVEK DHAN 62	49.	PUSA 44
10.	IMPROVED PUSA BASMTI 1	30.	ASD 20	50.	PUSA 33
11.	VIKASH	31.	POORNIMA	51.	PNR 546
12.	PANT DHAN 4	32.	MAHAMAYA	52.	PNR 162
13.	BASMATI 370	33.	SHYMLA	53.	SABARMATI
14.	JYOTI	34.	SARASWATI	54.	PUSA 834
15.	MAKOM	35.	IR 8	55.	PUSA BASMATI 1121
16.	NDR 359	36.	LOCHIT	56.	PNR 519
17.	PUSA SUGANDH 2	37.	KRISHNA VENI	57.	JD 13
18.	PUSA SUGANDH 3	38.	ARUNA	58.	PUSA BASMATI 1401
19.	PUSA SGANDH 5	39.	SUGANDHAMATI	59.	PNR 381
20.	MANDYA VIJYA	40.	CSR 13	60.	JD 6
				61.	RAVI

distribution and intensity along with presence or absence of auricles, collar, ligule and attitude of culm were recorded. Quantitative characteristics viz. length and width of leaf blade were also measured at booting stage. Number of days taken by 50% plants in each replication from sowing to flowering was recorded. The attitude of flag leaf blade and anthocyanin coloration of keel and apex along withcolor of stigma was recorded at anthesis stage. The stem length i.e. length of the main stem from the ground level to the panicle node was recorded during milk stage. Furthermore, the anthocyanin coloration of nodes and internodes was also recorded at the same stage. All the panicle characters viz. exertion, presence or absence of secondary branching; awn characters like distribution, color, length; color of lemma and palea; and panicle number per plant were recorded after the terminal

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spikelets ripened. When the caryopsis became hard i.e. could no longer be dented by thumbnail, the leaf senescence and color of sterile lemmae were recorded. The grain characters viz. weight of 1000 fully developed grains, grain length, width, and shape were recorded after harvest.

III RESULTS AND DISCUSSION

3.1 Polymorphism of characteristics

In the present study, fifty-five morphological descriptorswere used for varietal characterization. Out of fifty five morphological characteristics, forty four qualitative characters and eleven characters are quantitative, studied, among them six characteristics were found to be monomorphic (Table 2), nine characteristics were found dimorphic(Table 3), whereas forty characters were polymorphic (Table 4) in expression hence, indicating their potential for varietal identification. In another study by Joshi[7], varieties of rice belonging to non -basmati and basmati group were characterized based on the fifty two descriptors at different stages of plant growth.Nethra[8] observed polymorphism for traits of panicle awns, apiculus and node anthocyanin pigmentation, and stigma colour. Yan [9] also observed polymorphism for the traits days to 50% flowering, plant height, awn type, panicle type, plant type, color of lemma and palea, pubescence of lemma, decorticated grain colour, kernel length, kernel width, L/B ratio of kernel, test weight, endosperm amylose content and alkali spreading value based on 1,790 entries sampled from 114 countries. Polymorphism was observed for traits including test weight, kernel L/B ratio, amylose content, alkali spreading value and decorticated grain aroma by Singh [10]. A similar pattern of polymorphism was observed in the present study.

Table2: List of Monomorphic Characteristics

S. No.	Characters
1.	Leaf collar (present)
2.	Leaf collar: anthocyanin colour (absent)
3.	Male sterility (absent)
4.	Presence of amylose content in endosperm (present)
5.	Leaf ligule (present)
6.	Sterile lemma colour (white)

Table 3: List of Dimorphic Characteristics

S. No.	Characteristics
1.	Leaf: anthocyanin colouration (absent,present)
2.	Leaf sheath: anthocyanin colouration(absent, present)

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3.	Leaf auricle(absent, present)
4.	Panicle : presence of awn (absent, present)
5.	Panicle : presence of secondary branches (absent, present)
6.	Lemma phenol reaction (absent, present)
7.	Stem anthocyanin clouration of internode (absent, present)
8.	Stem anthocyanin colouration of node (absent, present)
9.	Leaf auricle: colour (absent, present)

Table 4: List of Polymorphic Characteristics

S. No.	Characteristics	S. No.	Characteristic
1.	Basal leaf sheath colour	**21**	Panicle: length of main axis
2.	Leaf : length of blade	**22.**	Panicle : curvature of main axis
3.	Spikelet : density of pubescence of lemma	**23.**	Panicle: number per plant
4.	leaf : intensity of green colour	**24.**	Spikelet : colour of tip of lemma
5.	Leaf : width of blade	**25.**	Lemma and palea: colour
6.	Lemma: anthocyanin coloration of keel	**26.**	Panicle: colour of awns (late observation)
7	Leaf : distribution of anthocyanin coloration	**27.**	Panicle : length of longest awn
8.	Culm : attitude	**28.**	Panicle: distribution of awn
9.	Lemma: anthocyanin coloration of area below apex	**29.**	Panicle : attitude of branches
10.	Leaf sheath: intensity of anthocyanin coloration	**30.**	Panicle: Exertion
11.	Time of heading(50 % of plants with panicles)	**31.**	Time maturity (days)
12.	Lemma: anthocyanin coloration of apex	**32.**	Leaf: senescence
13.	Leaf :Pubescence of blade surface	**33.**	Grain: weight of 1000 fully developed grains
14.	Spikelet: colour of stigma	**34.**	Grain : length (mm)
15.	Flag leaf: attitude of blade (early observation)	**35.**	Grain: width (mm)

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16.	Stem :thickness	**36.**	Decorticated grain: width (mm)
17.	Stem: intensity of anthocyanin colouration of node	**37.**	Decorticated grain: shape (in lateral view)
18.	Flag leaf: attitude of blade (late observation)	**38.**	Endosperm :content of amylose
19.	Stem: length (excluding panicle)	**39.**	Gelatinization temperature: through alkali value
20.	Decorticated grain length	**40.**	Leaf sheath : anthocyanin coloration

3.2 Identification Key

Themajor objective of the present study was to separate the varieties in to groups and then to identify them individually. To achieve the same, the variety of the present study were singled out using a combination of grouping characters and essential characters as listed in DUS guidelines(2007). The Basal Leaf Sheath Color could classify genotypes in to four categories: viz. light purple (Annada),purple line (Mahamaya), uniform-purple (CSR 27, Shymla, Aruna), and Green (all the rest 56 varieties). Further the three genotype in Uniform Purple group could be distinguished on the basis of pubescence of blade surface of leaf: weak in Shymla and medium in CSR27 and Aruna. These two could be singled out on the basis of Anthocyanin Colouration of Auricle: colourless in CSR27 and Light Purple in Aruna.Rest of the grouping were shown in fig 1. Similar identification key were prepared by Mondal[11].

In short, the cultivars in the present study showed overlapping of descriptor expression in various combination traits, but still the identity of all the cultivars in non-basmati as well as basmati group could be established individually.

3.3 Assessment of descriptor utility

A critical appraisal of the above mentioned identification key using grouping and essentials characteristics revealed that only a few characters viz. time of heading (50% plants with panicle, length of stem (excluding panicle), panicle length of main axis, decorticated grain length, basal Leaf sheath color, pubescence of blade surface of leaf, color of auricle, shape of ligule, flag leaf attitude (early observation), Pubescence of hair of lemma in spikelet, anthocyanin coloration of apex in lemma, Color at tip of lemma in spikelet, flag leaf attitude (late observation), presence of awn in lemma, panicle curvature of main axis used in the key sixteen of these listed characters, four were quantitative in state of expression, while rest twelve were qualitative in state of expression. With respect to time qualitative characteristics to differentiate varieties on the basis of color assessment likes basal leaf sheath color, auricle color, where the genotypes could be categorized easily in to various state of expression. However for the characteristicswhere anthocyanin coloration was involved like that of lemma; anthocyanin coloration of apex, the categorizationswas subjective and varied from person to person since genotype had to be grouped comparatively in to weak, medium, and strong.

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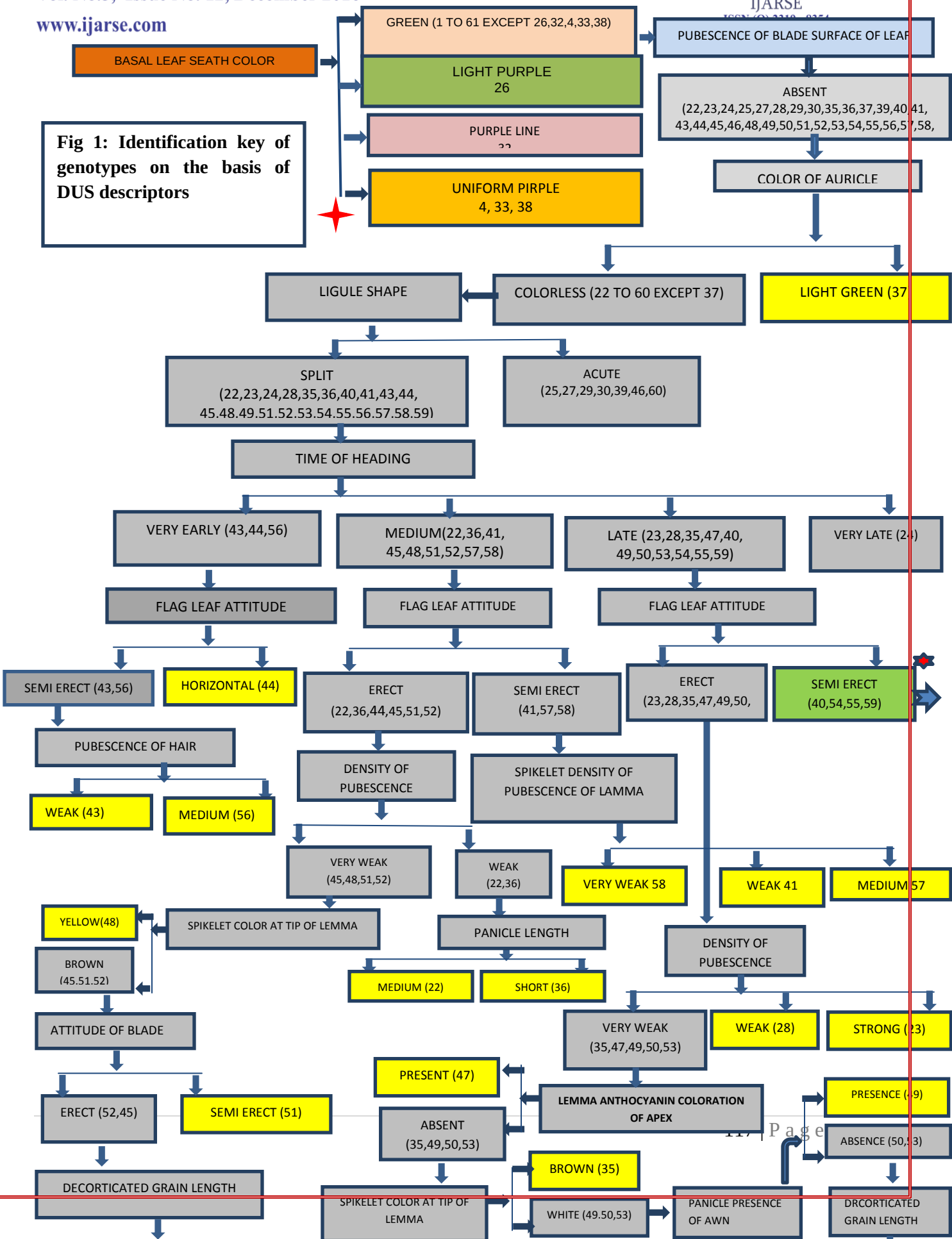

Fig 1: Identification key of genotypes on the basis of DUS descriptors

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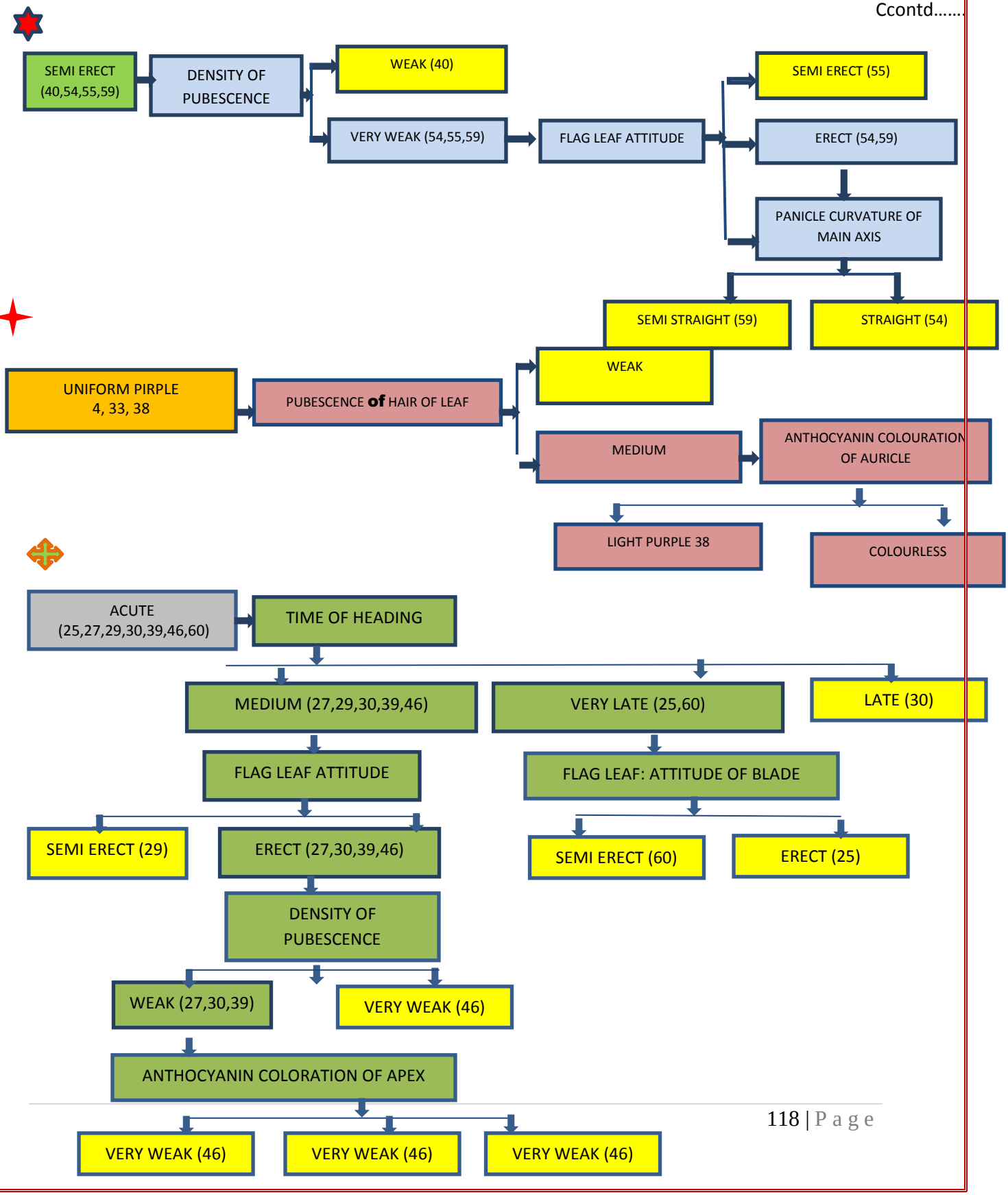

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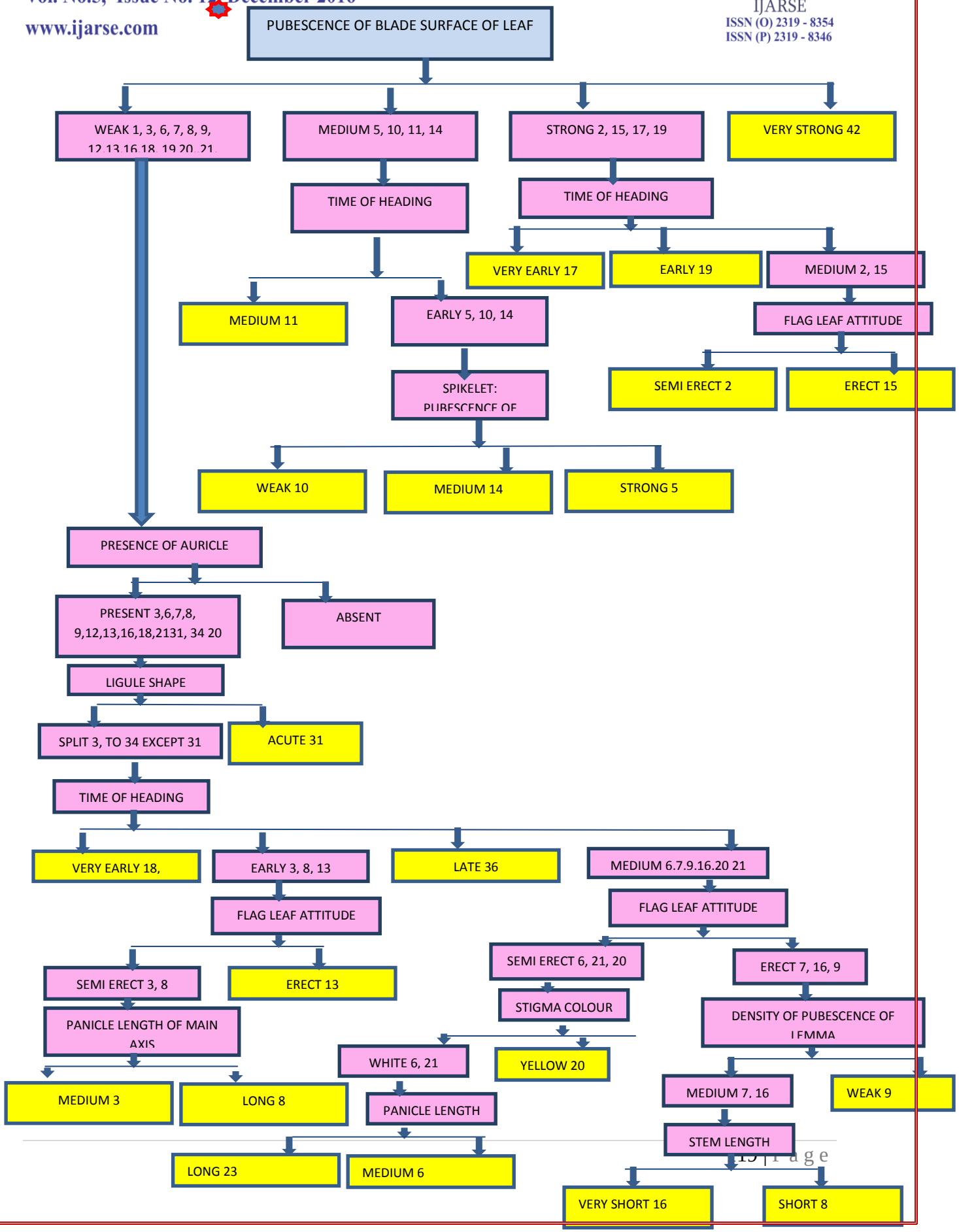

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Moreover characteristics like these one also subjective to environment influence since the color development is dependent upon the expose of plant part to sunlight. Hence, the grouping of varieties on the basis of this is a tedious job. Similar findings were reported by Suman [12], except for 'days to 50% flowering'. Joshi [13] also followed a similar approach to estimating descriptor utility

In addition as emerged from identification key, characteristics like pubescence viz. density of pubescence of lemma, pubescence of blade surface were hard to categorize from weak to medium to strong. Hence, the character expression needs to be modified from the present stated to include only two categories viz. absence or presence of pubescence to rule out the ambiguity in recording the same, and to reduce the level of subjectivity involved. Hence, it is suggested that in addition to the existing DUS guideline for establishing varietal distinctiveness, recent technologies like use of molecular markers or image analysis techniques need to be complemented with field morphological studies to have a more reliable assessment.

IV CONCLUSION

Breeders' seed of 61 varieties of rice belonging to non-basmati and basmati group was procured from the Breeder Seed Production unit of IARI New Delhi, and raised at the Divisional field of Seed Science and Technology. Plants were examined for different morphological characters during different growth stages in the field. Fifty-five morphological descriptors were used for varietal characterization. Out of fifty five morphological characteristics, forty four qualitative characters and eleven quantitative characters were studied, among them six characteristics were found to be monomorphic,nine characteristics were found dimorphic, whereas forty characters were polymorphicin expression hence, indicating their potential for varietal identification.A total of sixteen characteristics encompassing four quantitative and twelve qualitative traits were helpful in establishing varietal distinctness. The cultivars in the present study showed overlapping of descriptor expression in various combination traits, but still the identity of all the cultivars in non-basmati as well as basmati group could be established individually. Based on the identification key, a critical appraisal of the descriptor utility was also done. It was observed that for characteristics where anthocyanin coloration and pubescence was involved like lemma: anthocyanin coloration of apex, density of pubescence of lemma and pubescence of blade surface; the categorization was subjective and varied from person to person; since the genotypes had to be grouped comparatively in to weak, medium, and strong state of expression. Hence, the grouping of varieties on this basis was a tedious job. Hence, it is suggested that in addition to the existing DUS guideline for establishing varietal distinctiveness, recent technologies like use of molecular markers or image analysis techniques need to be complemented with field morphological studies to have a more reliable assessment.

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