# Assessment of Agro-Morphological characters among complete panicle emergence mutants of Samba Mahsuri (BPT-5204)


**ABSTRACT**

**Aims:** Main aim of the present work was to generate mutants using the chemical mutagen, ethyl methane sulphonate (EMS) in the popular rice variety Samba Mahsuri (BPT-5204) and characterize them for complete panicle emergence mutants of Samba Mahsuri.

**Place and Duration of Study:** The field evaluation was carried out repeatedly in two locations at Indian Institute of Rice Research, Rajendranagar, and at ICRISAT Patancheru, Hyderabad. The duration of the study was three successive seasons in triplicates namely, june-2014, january-2015 and june-2015.

**Methodology:** Seedlings of 28-30 days old were transplanted in 5 lines (each line containing 20 plants) into the field. The plant spacing was 20cm by 15cm with density of one hill. The field was irrigated throughout the experiment with average of 10cm water above the soil level. Regular hand weeding was embarked upon to free the plant of inter specific competition. The phenotypic data was recorded for CPE mutants through visual assessment. The characteristics that required measurements were done according to the usual procedure. The Distinctness, Uniformity and stability of the CPE mutant lines have been recorded following (DUS) test guidelines.

**Results:** The identified stabilized thirteen complete panicle emergence (CPE) mutants showed superior agro morphological characters, compared with wild type (BPT-5204). The mutants CPE-2 and CPE-3 took 100 days to flowering and CPE-4 and CPE-7 mutants showed superiority for panicle length, and CPE-5 exhibited good performance for grain yield. In correlation analysis CPE trait had a significantly positive correlation with PH and TGW and negative correlation with 50%DFF. The CPE mutants used in the present study exhibited variability for most of the studied traits. Significant variation was detected in the identified stabilized CPE mutants for plant height, panicle length, flag leaf length and width, 50% flowering, different grain types and 1000 grain weight.

**Conclusion:** The present study discovered adequate genetic divergence in the thirteen stabilized CPE mutants for various qualitative and quantitative traits. The promising mutants identified during the current study have the potential to be used in future breeding programs for getting productive and quality results.


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*Keywords:* Samba Mahsuri (BPT-5204), Mutation, Complete panicle exsertion (CPE), Biotic, Abiotic


## 1. INTRODUCTION:

Rice (*Oryza sativa* L.) is an important staple food for more than half of the world's population. In India 70-75% of the people mainly depend on rice. Rice plays an important role in shaping the cultures, diet and economies of millions of people by provide food and nutritional security eradicating poverty (12). Induced mutagenesis is one of the powerful tools to increase the extent of variation in the gene pool of rice. Mutation breeding is used for the enhancement of specific loci controlling economically valuable traits (6).The mutation breeding technology is one of the best approaches to generating national mutant resource for functional genomics studies. Mutation breeding approaches are being widely used throughout the world for biotic, abiotic stresses in various crops (1). Samba Mahsuri (BPT-5204) is one of India's most popular and highly prized rice varieties because of its high yield and excellent cooking quality. It is cultivated in 1-2 million hectares of land across India. Unfortunately Samba Mahsuri (BPT-5204) variety is susceptible to many biotic, abiotic stresses and exhibits incomplete panicle emergence, leads to reduction in the 10-20% total crop yield. Complete panicle emergence is economically important trait which influences the emergence of panicle out of flag leaf, resulting in to the complete grain filling and increase crop yield. Panicle emergence defines as distance between flag leaf and panicle is the important morphological trait of rice, which seriously affects the production of seeds (17).

Ethyl methane sulphonate is one of the powerful alkylating agents and it was frequently used for chemical mutagenesis.EMS is more effective than physical mutagens (5,2) and it mainly causes GC to AT transition in the plant

genome (13,9).EMS mutagenesis is one of the supplementary approach to identify desired characters such as economically important yield related characters in rice (3).

Main aim of the present work was to generate mutants using the chemical mutagen, ethyl methane sulphonate (EMS) in the popular rice variety Samba Mahsuri (BPT-5204) and characterize them for complete panicle emergence mutants of Samba Mahsuri.

## 2. MATERIAL AND METHODS:

Seedlings of 28-30 days old were transplanted in 5 lines (each line containing 20 plants) into the field. The plant spacing was 20cm by 15cm with density of one hill. The field was irrigated throughout the experiment with average of 10cm water above the soil level. Regular hand weeding was embarked upon to free the plant of inter specific competition. The field evaluation was carried out repeatedly in two locations i.e. at Indian Institute of Rice Research, Rajendranagar, and at ICRISAT Patancheru, Hyderabad.

### 2.1 Assessment of Samba Mahsuri mutants for complete panicle emergence

In order to characterize complete panicle emergence mutants of Samba Mahsuri, screening carried out at two different locations namely IIRR, Rajendranagar, Hyderabad and at ICRISAT, Patancheru, Hyderabad. Complete panicle emergence in mutants was measured at the time of maturity from the base of panicle to the tip of the last spikelet. The mutant lines panicle internodes were emerged completely from the flag leaf. The mutants with panicles emerged completely from the flag leaf were selected as Samba Mahsuri mutants with complete Panicle emergence.

To know, the complete panicle emergence mutants of Samba Mahsuri, this Indica variety (BPT-5204) was extensively screened at IIRR, Rajendranagar, Hyderabad and ICRISAT, Patancheru Hyderabad, for the three seasons in triplicates namely, june-2014, january-2015 and june-2015. Samba Mahsuri (BPT-5204) panicles emerge partially and the partially emerged panicles produce chaffy grains/partially-filled grains and affect the unabridged grain recovery during harvesting. This characters makes Samba Mahsuri is an ideal genotype for identifying mutational changes in traits of panicle exsertion.

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#### 2.1.1 To evaluate the agro-morphological characters of CPE mutants

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The phenotypic data was recorded for CPE mutants through visual assessment. The characteristics that required measurements were done according to the usual procedure. The Distinctness, Uniformity and stability of the CPE mutant lines have been recorded following (DUS) test guidelines. The phenotypic data was recorded at maturity stage of the rice crop for characters like panicle morphology and data for quantitative characters like plant height, number of tillers/plant, number of reproductive tillers/plant, flag leaf length, flag leaf width, panicle length, grain type, days to 50% flowering, number of spikelet's/panicle, total plant yield, and 1000 seed weight were also recorded.

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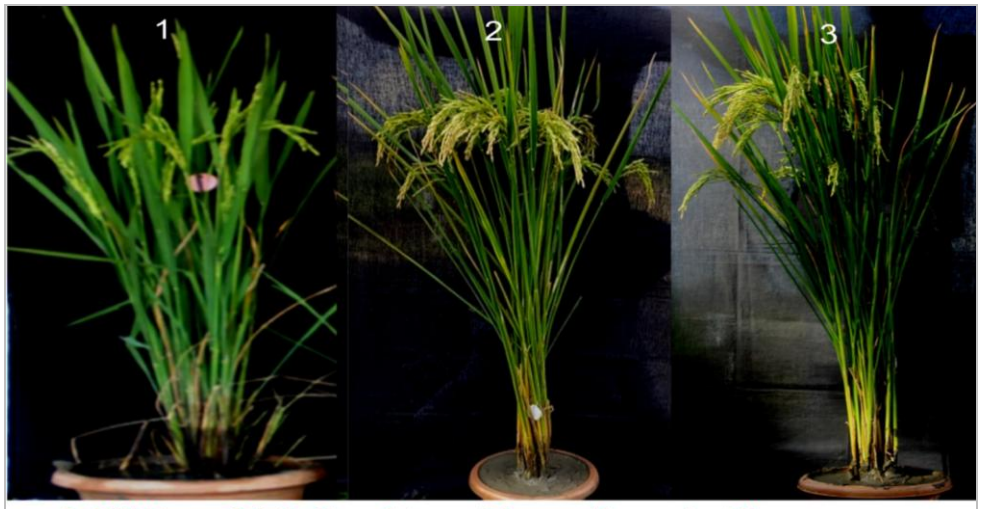
Agro morphological characters were carried out at the 50% flowering stage and full maturity stage of the plants. In this study 13(M8) complete panicle emergence mutant lines of agro-morphological characters data were recorded for following 12traits.

**Fig: a-Comparison between wild type and CPE mutants**




1: Wild type; 2 & 3: Complete panicle exsertion mutant lines

## 3. RESULTS AND DISCUSSION

### (1)Plant Height (cm):

The plant height was measured from the base of the plant to the tip of main panicle. Highly significant difference was observed for plant height, among thirteen CPE mutant lines have shown minimum 83 cm (CPE-1) to maximum 120cm (CPE-7) .One mutant CPE-1 showed plant height of 83cm, is equal to wild type plant height(Table:2).

Comment [DL6]: Methodology

### (2)Number of tillers/plant:

Total number of tillers/plant was calculated at the time of maturity stage of the plant. All thirteen CPE mutants were showed less tillers/plant ranging from minimum 15(CPE-10) to maximum 24(CPE-1).where as in wild type total tiller number/plant is 27(Table:2).

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### (3) Number of productive tillers/plant:

Highly significant differences were observed among thirteen CPE mutants for number of productive tillers, and it was ranging from minimum 13 (CPE- 3) to maximum 23(CPE-1), whereas wild type showed 15 reproductive tillers (Table:2).

### (4) Flag leaf length (cm):

Significant variation was observed among thirteen CPE mutants for flag leaf length. Length of the flag leaf in CPE mutants was less compared with wild type. In CPE mutant's flag leaf length ranging from minimum 26cm (CPE-3 &CPE-9) to maximum 33cm (CPE-11).In case of wild type length of the flag leaf is 35cm(Table:2& fig:b)

**Fig-b: Measurement of CPE mutant lines flag leaf length**

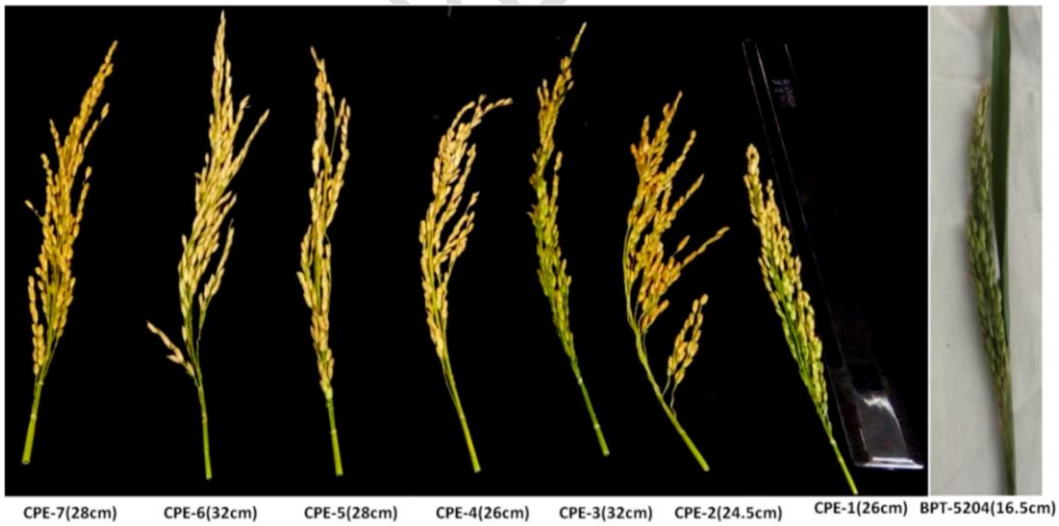
**(5)Flag leaf width (cm):**

Highly Significant variation was observed among thirteen CPE mutants for flag leaf width. In CPE mutant's flag leaf width ranging from minimum 1.2cm (CPE-1, 9&10) to maximum 2.2cm (CPE-4).In case of wild type width of flag leaf is 1.2cm(Table:2).

**(6)Panicle length (cm):**

Panicle length was measured in centimeters at the time of maturity stage of the plant. Panicle length was measured from the base of the panicle to the tip of last spikelet prior to harvesting. Stabilized CPE mutant lines showed significant variation in the panicle length. Length of the mutant line panicle ranging from minimum 22cm (CPE-3) to maximum 32 cm (CPE-4 &7).In case of wild type length of the panicle is 16.5cm (Table: 2&fig: c).

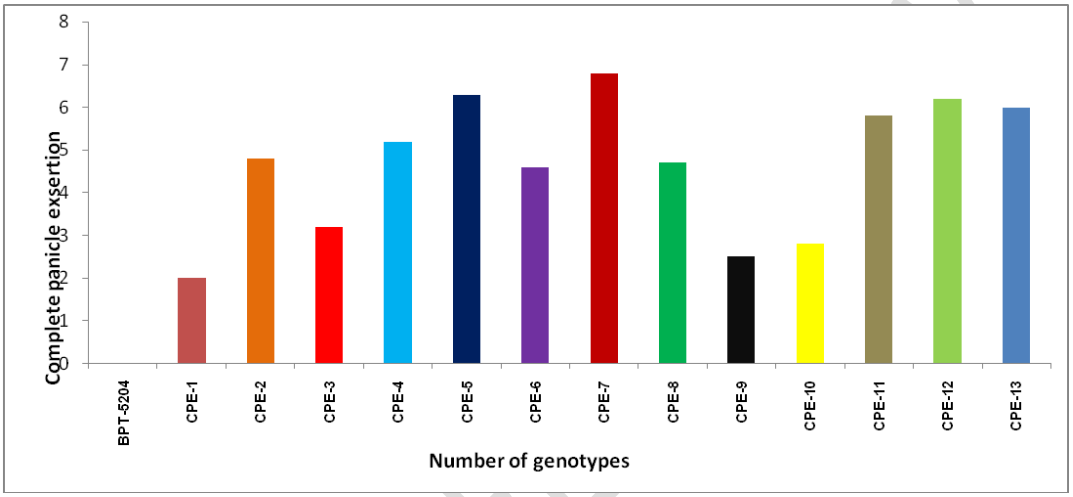
**Figure-c: CPE mutants showed significant variation in panicle length**



**(7)Complete panicle exsertion (CPE):**

Complete panicle exsertion was measured in centimeters at the maturity stage of the plant.CPE was measured from the flag leaf to the panicle base using a ruler.CPE mutants showed significant difference in panicle exsertion ranging from maximum CPE-7(6.8cm) to minimum CPE-1(2cm).But in case of wild type 10-20% panicle choking was observed. In Samba Mahsuri 4-5cm panicle was present within the flag leaf (Table: 2&fig:d).

**Figure: d: CPE mutants showed significant difference in complete panicle exsertion**




**(8) Grain type:**

Four different grain types were identified among thirteen CPE mutant lines. In the current study, grain lengths were recorded according to Hailiang Mao (7). The mutants with different grain types like long slender (L/B>3.0), long bold (L/B<3.0), medium bold (L/B<2.5), and medium slender (L/B 2.5-3.0) were identified. Eight mutant lines (CPE-1,3,7,9,10,11,12&13) showed medium slender grain(MS) like wild type, two mutant lines(CPE-5&6) showed long slender grain(LS),two mutant lines (CPE-2&4) showed medium bold (MB) and one mutant line CPE-8 showed long bold(LB) grain type(Table:2&fig:d).

**(9) Days to 50% flowering:**

Significant variation was observed among thirteen mutants for days to 50% flowering, minimum 100days (CPE-2&3) to maximum 115days (CPE-1,CPE-9&CPE-10).Among thirteen genotypes three genotypes showed 115days to 50% flowering like wild type(Table:2).

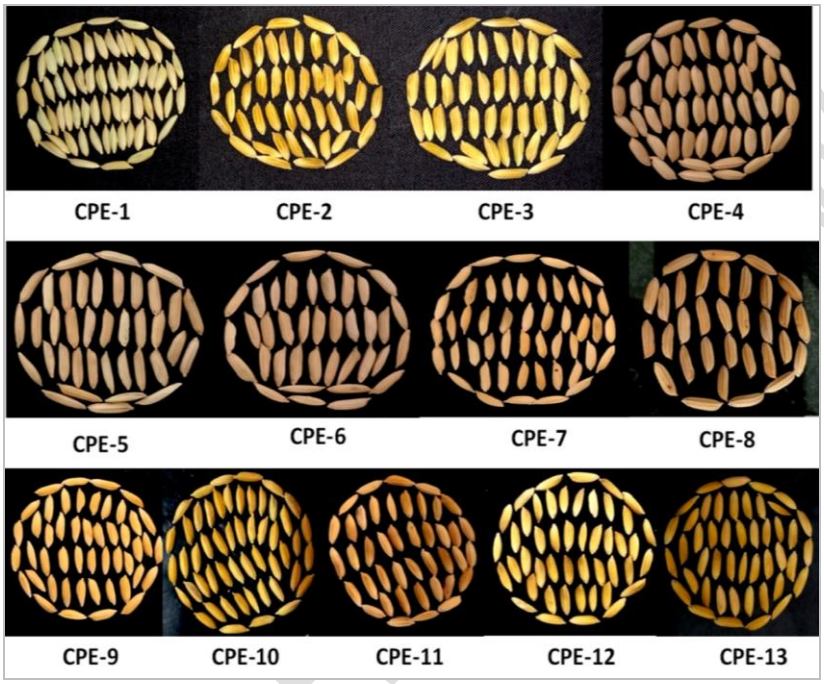
**(10) Number of filled grains/panicle:**

Significant variation was observed among thirteen mutants for number of grains per panicle, ranging from minimum 202 (CPE-13) to maximum 225 (CPE-11). In case of wild type number of filled grains per panicle is 200, which is lower than the CPE mutant lines (Table: 2).

**(11) Single plant yield (gr):**

Highly significant difference was observed among thirteen mutants for plant yield, it was ranging from minimum 20grams (CPE-3) to maximum 26.4(CPE-5), which is higher than the wild type 15.8gr (Table: 2).

**Fig-e: CPE mutant lines with different grain types**




**(12) 1000 seed weight (gr):**

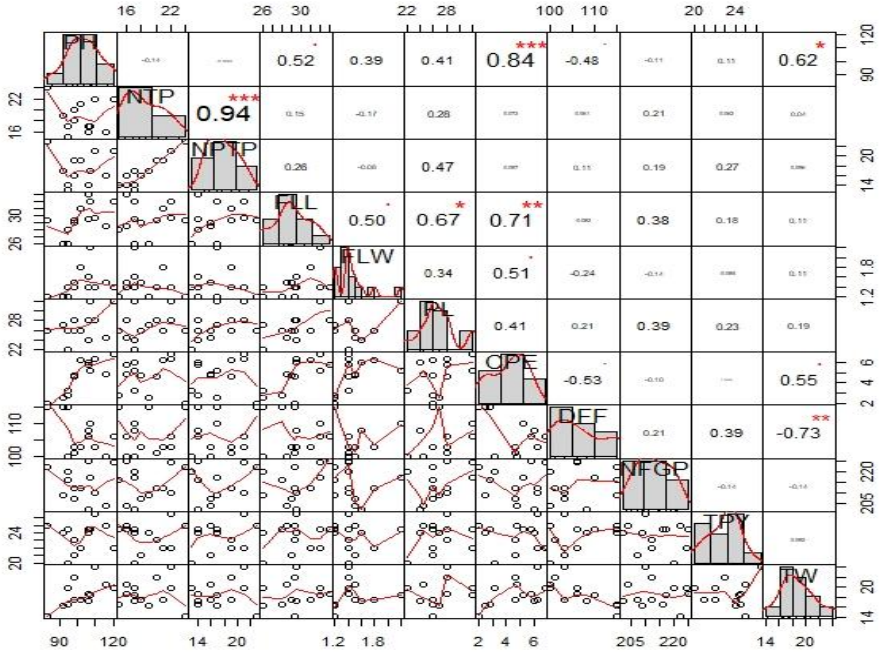
Among thirteen genotypes significant variation was observed for 1000 seed weight. It was ranging from maximum 23.99gr (CPE-5) to minimum14.12gr (CPE-1). Among 13 CPE mutants CPE-1 showed less (14.12 gr) 1000 seed weight, compare with wild type. Test weight of wild type is 15.2gr (Table: 2).

### 3.1 Correlation data between agro-morphological characters of CPE mutants:

The degree of correlation between the traits is significant in plant breeding. It can be used as tool for indirect selection. Correlation studies help the plant breeder during selection and provide the understanding of yield components.

The results of correlation analysis reveals that CPE trait showed positive and highly significant correlation with plant height (r=0.84), flag leaf length (r=0.71), test weight(r=0.55), and flag leaf width(r=0.51) respectively. However, number of reproductive tillers/plant(r=0.94) showed highly positive and significant correlation with number of tillers/plant. Among eleven characters panicle length showed positive correlation with flag leaf length (r=0.67), and plant height(r=0.62) showed positive correlation with test weight.

**Fig-f: Pearson's correlation coefficients among thirteen CPE mutants**




PH=plant height, PL=panicle length, FLL=flag leaf length, NTP=number of tillers/plant, NRT= number of reproductive tillers/plant, FLW=flag leaf width, SPY= single plant yield, DFF=days to 50% flowering, TW= 1000 test weight, NFG= number of filled grains/panicle.

However, days to 50% flowering showed highly significant negative correlation with CPE (-0.53), test weight (-0.73), plant height (-0.43), flag leaf length (-0.08), and flag leaf width (-0.24) respectively.

### 3.1.1 DISCUSSION:

Assessment of CPE mutants through various morphological traits is an important step for assessment of its genetic potential. Improve in grain yield potential is the most important goal of the rice breeders. To enhance the yield and yield contributing traits in rice, mutation breeding is the best available choice. Samba Mahsuri is a popular rice variety with good cooking quality characteristics. It is susceptible to many biotic and abiotic stresses and it exhibits incomplete panicle emergence. To overcome this problem, increase the extent of variation in gene pool of rice by using mutation breeding is the potent way. To develop a rice variety with medium slender grain, good cooking quality, and early duration with high yielding than Samba Mahsuri is the biggest task for plant breeders. So, in this current study Samba Mahsuri was used to create genetic variation through EMS mutagenesis (Mutation breeding).Stabilized thirteen CPE mutants were analyzed separately for different agronomic traits. Compare with Samba Mahsuri a notable variation was observed among thirteen CPE mutant lines for yield and yield contributing traits.

In this present study, among thirteen CPE mutants, eleven genotypes showed semi dwarf plant height (80-110cm) and exhibits higher single plant yield. Semi dwarf plant height is a key feature for higher yield production (14, 10). Correlation studies for a number of agronomic traits with panicle exsertion (PE) have been reported by Yang (18) and Hori (10). Earlier researchers reveal that the panicle exsertion was positively correlated with PH, PL, and TGW (18, 4).It implies that PE plays a crucial role in the regulation of grain weight. Similarly in this present study we found that CPE had a significantly positive correlation with PH and TGW. It had a significant positive correlation with FLL, and FLW. It is well

known that 50% flowering (DFF) is one of the most important agronomic trait in rice (15,11).Current study reveals that DFF had a highly significantly negative correlation with CPE, which was similar to the results reported by (18,4).However, in this current study we found that DFF had significantly negative correlation with PH, TGW, FLL and FLW. The CPE mutants used in the present study exhibited variability for most of the studied traits. Significant variation was detected in the identified stabilized CPE mutants for plant height, panicle length, flag leaf length and width, 50% flowering, different grain types and 1000 grain weight.

**Table 1.CPE mutants quantitative traits**

| List of quantitative traits | | |
|---|---|---|
| **Growth trait/yield trait** | **Denotation** | **Method of evaluation** |
| **Plant height(cm)** | **PH(cm)** | **The average height from the base to the tip of the main panicle** |
| **Number of tillers/plant** | **NT(number)** | **Count the number of tillers per plant** |
| **Number of productive tillers/plant** | **NPT(number)** | **Count the number of productive tillers per plant** |
| **Flag leaf length(cm)** | **FL (cm)** | **measure the length of the flag leaf** |
| **Flag leaf width(cm)** | **FLW(cm)** | **Calculate the width of the flag leaf** |
| **Panicle length(cm)** | **PL(cm)** | **Measure the panicle length from the node below the lowest branch on the panicle to the top of first superior spikelet** |
| **Complete panicle exsertion** | **CPE(cm)** | **Measure from the flag leaf to the panicle base using a ruler** |
| **Grain type** | **GT** | **Record the different grain types in the all the accessions** |
| **Days to 50% flowering** | **DFF(days)** | **Count the number of days from seeding to flowering** |
| **Number of filled grains/panicle** | **NFG/P(number)** | **Count the number of spikelet's per panicle** |
| **Yield/Plant(gm)** | **Y/P(gm)** | **Weigh total grains produced per plant** |
| **1000 grain weight(gm)** | **1000GW(gm)** | **Weigh any 1000 filled grains** |

**Table: 2 Agro-morphological data of CPE mutants**

| Trait/ Characters | Wild type | COMPLETE PANICLE EMERGENCE MUTANTS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BPT-5204 | CPE-1 | CPE-2 | CPE-3 | CPE-4 | CPE-5 | CPE-6 | CPE-7 | CPE-8 | CPE-9 | CPE-10 | CPE-11 | CPE-12 | CPE-13 |
| PH | 83.0 | 83.0 | 116.0 | 95.0 | 107.0 | 110.0 | 98.0 | 120.0 | 98.0 | 92.0 | 95.0 | 106.0 | 102.0 | 106.0 |
| NTP | 27.0 | 24.0 | 16.0 | 17.0 | 17.0 | 22.0 | 20.0 | 22.0 | 18.0 | 19.0 | 15.0 | 16.0 | 21.0 | 17.0 |
| NPTP | 15.0 | 23.0 | 16.0 | 13.0 | 17.0 | 21.0 | 19.0 | 21.0 | 16.0 | 17.0 | 14.0 | 14.0 | 19.0 | 14.0 |
| FLL | 35.0 | 29.3 | 28.5 | 26.0 | 32.0 | 29.6 | 29.3 | 32.0 | 29.0 | 26.0 | 28.0 | 33.0 | 31.0 | 29.5 |
| FLW | 1.2 | 1.2 | 1.5 | 1.4 | 2.2 | 1.4 | 1.4 | 1.4 | 1.5 | 1.2 | 1.2 | 1.4 | 1.8 | 1.6 |
| PL | 16.5 | 26.0 | 24.5 | 22.0 | 32.0 | 28.0 | 28.0 | 32.0 | 26.0 | 27.0 | 26.0 | 28.0 | 26.0 | 24.0 |
| CPE | 0.0 | 2.0 | 4.8 | 3.2 | 5.2 | 6.3 | 4.6 | 6.8 | 4.7 | 2.5 | 2.8 | 5.8 | 6.2 | 6.0 |
| GT | MS | MS | MB | MS | MB | LS | LS | MS | LB | MS | MS | MS | MS | MS |
| DFF | 115.0 | 115.0 | 100.0 | 100.0 | 110.0 | 103.0 | 101.0 | 106.0 | 103.0 | 115.0 | 115.0 | 106.0 | 103.0 | 108.0 |
| NFGP | 200.0 | 222.0 | 204.0 | 220.0 | 217.0 | 210.0 | 212.0 | 224.0 | 207.0 | 209.0 | 216.0 | 225.0 | 212.0 | 202.0 |
| TPY | 15.8 | 25.0 | 25.0 | 20.0 | 24.4 | 26.5 | 23.0 | 22.0 | 21.0 | 24.0 | 24.5 | 24.5 | 22.0 | 24.0 |
| TW | 15.2 | 14.1 | 20.6 | 19.7 | 18.4 | 24.0 | 21.8 | 19.9 | 17.5 | 16.3 | 16.5 | 18.5 | 17.5 | 17.2 |

PH: Plant height; NTP: Number of tillers/plant; NPTP: Number of productive tillers/plant; FLL: Flag leaf length(cm); FLW: Flag leaf width(cm)**; PL:** Panicle length(cm); CPE: Complete Panicle exsertion; GT: Grain type; DFF: Days to 50% flowering; NFGP: Number of filled grains/panicle; TPY: Total plant yield(gm); TW: 1000 seed weight(gm).

## 4. CONCLUSION

The present study discovered adequate genetic divergence in the thirteen stabilized CPE mutants for various qualitative and quantitative traits. The mutants CPE-2 and CPE-3 exhibits minimum 100days to 50% flowering, while genotypes CPE-4 and CPE-7 showed superiority for panicle length. The genotype CPE-5 exhibited good performance for grain yield and 1000 grain weight and CPE-7 exhibited good panicle exsertion. CPE had a significantly positive correlation with PH, and TGW and highly significant negative correlation with 50%DFF.

In this study, we concluded that the identified stabilized complete panicle emergence mutants showed superior agro morphological characters compared with wild type. The promising mutants identified during the current study have the potential to be used in future breeding programs for getting productive and quality results. These phenotypic characters were played key role in crop improvement and same material can use as donor material for breeders to transfer into another genetic background.

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