Original Research Article

Seed Germination, Vegetative Growth and Flowering Performance of Cockscomb (*Celosia cristata* L.) in Response to Different Potting Media

ABSTRACT

The experiment was carried out at the Horticulture Garden, Department of Horticulture, Sindh Agriculture University, Tandojam, Pakistan, during the cropping season March 2017 to May 2017. To estimate germination percentage, vegetative growth and flowering performance of Cockscomb (*Celosia cristata* L.) in response to different potting media. Aim of the research was to evaluate the best potting media and select the best segregating genotype of Cockscomb for superior performance on flowering traits. The trial was laid out in randomized complete block (RCBD) with three replications. The experiment consisted with two genotypes G1 (Amigo Red) and G2 (Prestige scarlet) were planted in different potting media T_1 (100% Canal sediment), T_2 (75% Canal sediment + 25% FYM), T_3 (50% Canal sediment + 50% Coco peat), T_4 (25% Canal sediment + 50% bagasse + 25% Coco peat) and T_5 (25% Canal sediment + 70% bagasse + 5% Coco peat) in the earthen pots. Our present findings of genotype (G2) in potting media (T_4) indicated highest seed germination percentage (87.50%), germination index (1.77), plant height (36.55 cm), seedling vigor index (3394.2), fresh weight of shoot (56.40 g), fresh weight of root (13.35 g), fresh weight of a single flower (16.97 g), days taken to initiate flowering (74.88 days), number of flowers per plant (5.05) and chlorophyll content of leaf (36.08%). To compare mean of the G2 obtained better results in comparison to genotype (G1). The interaction of the genotypes and potting media was highly significant in G2 from the plants grown in (T_4) potting media. This study showed that based on the potting media performance of the Cockscomb genotypes found maximum performance in (T_4) potting media at Tandojam location. Others potting media along with genotypes and geographical locations might be explored for future research activities.

Keywords: Amarantaceae, Cockscomb, potting media, germination, growth, flowering behavior

1. INTRODUCTION

Cockscomb (*Celosia cristata* L.) is mostly grown for use in landscape, regardless there are some hybrid land racers commercially used as cut flowers too. The flower resemblance to rooster head for which it is termed as Cockscomb [1]. It is one of the most versatile annual herbaceous plants with different colours, ranging from shades of red, purple, gold, orange and yellow including multicolored flower heads and it is a decorative flowering annual grown in warm countries mainly in the tropical and subtropical region [2]. In Pakistan, Cockscomb is locally termed as Kalgha and is sown during March-April and September to January as a beautiful ornamental plant and cut flowers. Due to versatile flower colors *C. cristata* has a great economic value as a cut flower throughout the world. Its demand as a cut flower has been on inclined because of attractive shapes and better vase life. Variant environmental conditions of Sindh in Pakistan have made the Cockscomb cultivation challenging [1].

Cockscomb is grown as an annual ornamental plant and ornamental plants needs growing media plus adequate water retention and aeration [3] plus fertilizer formulation that assures a continuous nutrient [4]. Suitable growing media are essential for quality flower production as these affect development and maintenance of plant rooting system [5,6]. Garden topsoil is commonly used by most of the growers for raising most of the flower crops, however, it is a nonrenewable resource and sustainable flower production cannot rely on non-renewable natural resources [7]. Moreover, phenomenal and infrastructure development immediately reduces affective availability the quality of subsoil which necessitates use of alternate soilless substrates for flower production. Besides soil is the main cause of the pathogens. The production of ornamental plants have depended most entirely on quality soil-fewer medium derived from both organic and inorganic component [8]. Soilless media have shown trendy with the majority of producers' causes of consistency, accomplished aeration, reproducibility, and low bulk density that reduce shipping and handling costs of the moderate itself and of the finished plants [9]. A significant relationship exists between different growing media combinations and flower yield and quality parameters [10].

Nowadays it is very common to grow container plants in various commercial growing media instead of plantation in the soil and this can be possible solution against soil related problems [11]. Coco peat is an agricultural outgrowth access subsequently the eradication of fiber from the coconut husk. As a growing media, coco peat could be used for production a numeral of crop species among the tolerable condition at the tropics. Coco peat is treated as a best growing medium composing among adequate pH, EC including other chemical aspect. Coco peat has been accepted to have more water holdings capacity that causes low air-water analogy, dominant to poor aeration within the media, thusly stirring the O_2 diffusion to the roots. Natural components of coco peat are more dependent on it processing technique and handling and the air space and water withholding of the material could be vary from 11-53 and from 50-81% respectively [5]. Bagasse exists of almost 50% cellulose and 25% each of hemicelluloses and lignin. Chemically, bagasse consists about50%-cellulose, 30% pentose and 2.4% ash. Cause of its poor ash contented, bagasse attempt numerous advantages for usage in bioconversion processes using microbial cultures. Further, in similarity to other agricultural residues, bagasse could be conceded as a rich solar energy reservoir due to its great yields including annual regeneration capacity [12]. So there is a need to optimize protocol for growing media by using cheap source of materials of local premises that are easily available in large scale for raising of healthy and quality plants of Cockscomb.

To enhance consumer's attraction and better income, flower size plays a significant contribution. Its production under unfavorable climate has been neglected for that no research in the past has been initiated to explore this natural gift. Therefore, few researches has been initiated to find out the most appropriate potting media on Cockscomb to commercialize and its vegetative quality and flower production under the subtropical environment of Sindh, Pakistan. Our present experiment has been planned to investigate the proper potting media of Cockscomb for good growth, best flower quality and maximum production under environmental conditions of Tandojam to promote this beautiful ornamental cut flower.

2. MATERIALS AND METHODS

The experiment was conducted at Horticulture Garden, Department of Horticulture, Sindh Agriculture University, Tandojam, during the cropping season March 2017 to May 2017. The experiment was laid out in randomized complete block (RCBD) with three replications. Two genotypes of Cockscomb G1 (Amigo Red) and G2 (Prestige scarlet) were planted in different potting media T_1 (100% Canal sediment), T_2 (75% Canal sediment + 25% FYM), T_3 (50% Canal sediment + 50% Coco peat), T_4 (25% Canal sediment + 50% bagasse + 25% Coco peat) and T_5 (25% Canal sediment + 70% bagasse + 5% Coco peat) in the earthen pots. Observations recorded on Seed germination percentage (SGP), Days to germination time (DGT), Germination index (GI), Plant height (PH), Seedling vigor index (SVI), Fresh weight of shoot (FWS), Fresh weight of root (FWR), Fresh weight of a single flower (FWSF), Days taken to initiate flowering (DTIF), Number of flowers per plant (NFPP), Electrolyte leakage of leaf (ELL) and Chlorophyll content of leaf (CCL).

Seed germination percentage (SGP) was calculated as the cumulative number of germinated seeds with normal radicles by following formula Larsen and Andreasen [13]:

$$GP = \Sigma n \ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation\ (1)$$

where n is number of seeds that had germinated at each counting.

Mean germination time (MGT) in days was calculated according to Ellis and Roberts [14]:

$$\mathrm{MGT} = \frac{\Sigma(Dn)}{\Sigma n} \ldots\ldots\ldots\ldots\ldots\ldots Equation\ (2)$$

where n is number of seeds germinated on day D, and D is number of days counted from the beginning of the germination test.

Germination index (GI) was estimated by the following equation by Khaleghi [15].

$$\mathrm{GI} = \frac{\text{Germinated seed number at the first day}}{\text{Days to the first counting}} + \frac{\text{Germinated seed number at the last day}}{\text{Days to the last counting}} \ldots\ldots\ldots\ldots\ldots\ldots Equation\ (3)$$

The following equation was used to estimate seed vigor index (SVI) by Agrawal [16].

$$\mathrm{SVI} = \frac{\text{Mean plumule length (in mm)} \times \text{Germination percentage}}{100} \ldots\ldots\ldots\ldots\ldots\ldots Equation\ (4)$$

Electrolyte leakage of leaf (%) was measured by taking 1 cm^2 leaf disc and weighing 0.5 g from random samples of leaf. The leaf disc was rinsed well with deionized water prior to incubation in 25 ml of deionized water for 3 hours at room temperature. After incubation, the conductivity values (value A) of the bathing solution were measured with the conductivity meter. The petal a disc was boiled with bathing solution for 15 minutes to lyses all cells. After cooling at room temperature, the conductivity (value B) of the bathing solution was again measured. The electrolyte leakage was expressed as percent value according to the formula given below:

$$\text{Electrolyte Leakage of leaf } (\%) = \frac{\text{Value A}}{\text{Value B}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots Equation\ (5)$$

*Chlorophyll content w*as taken with a portable chlorophyll meter using SPAD Chlorophyll Meter. The collected data were statistically analyzed by SAS Software Package, and the means were compared by the LSD test at the 1% and 5% probability levels.

3. *RESULTS AND DISCUSSION*

3.1. Germination Characters

3.1.1. Seed germination percentage (SGP)

The analysis showed significant (P<0.05) influence of potting media on the seed germination of Cockscomb. The results regarding the seed germination percentage of Cockscomb genotypes as influenced by different potting media has been demonstrated in Table 1 & Fig.1. The data means of seed germination percentage (SGP) ranges (50.00 to 82.50%), the highest T_4 (90.00%) in G2 and lowest observed in T_1 (G1). The means of seed germination percentage was significantly influenced in the different potting media interaction. On the others hand, previous experiment [17,18] showed that similar effect on the different potting media, respectively.

3.1.2. Days to germination time (DGT)

The results regarding the days to germination time of Cockscomb genotypes showed that mean of the potting media ranges (2.66 to 4.50 days) in Table 1 & Fig.2. It has been found from the results that the Cockscomb plant found minimum days to seed germination time (3.41 days) in T_4 (G1) and maximum observed in T_2 (G2). However, statistically Cockscomb seeds found similar time for seed germination in T_1 and T_5 potting media. These results are better than G2 (4.91 days) observed in T_2 potting medium. To compare Cockscomb genotype (G2) found more times (3.85 days) for germination as compared to genotype G1 (3.10 days). Present study is in accordance with Akinbode *et al.* [19] who reported that the germination was prompt in seeds of *A. cruentus* (3.22 days) and *C. olitorus* (4.44 days) under late sowing 25^{th} March while the seeds of *D. regia* germinated more on 10^{th} April. Whereas, germination of *C. argentea* and *A. esculentus* at early sowing 15^{th} February had no main effect.

3.1.3. Germination index (GI)

Germination index varied highly significant were different potting media as presented in Table 1 & Fig.3. All the treatments had mean values statistically similar found in the germination index except

(T_4) potting media. The highest germination index observed in potting media T_4 (1.95) in (G2) genotype and lowest was observed T_1 (0.78) in (G1) genotype. Based on genotypes non-significant differences were observed in potting media T_4 (G1 and G2). Dubey *et al.* [20] concluded that soil + sewage sludge as growing media for petunia have high positive effect and significantly improved most germination index included number of leaves and branches per plant. The desirable impact of different potting media on germination index has been reported by many studies [17,21,22].

3.1.4. Seedling vigor index (SVI)

The seedling vigor index is calculated on the basis of shoot length percentage of seed germination. The analysis of variance demonstrated that seedling vigour index of Cockscomb was significantly affected by different potting media (Table 2 & Fig. 4). That seedling vigour index was relatively higher mean of Cockscomb in T_4 (3394.2) as compared to the (T_1) genotype G1 (1146.7). The different potting media showed that the seedling vigour index of Cockscomb was highest G2 (5143.3) in potting media (T_4), while the seedling vigour index was relatively lower G1 (765.0) in (T_1), respectively. Our present experiment strongly supported by [23,24].

3.2. Plant height (PH)

The results regarding the plant height of Cockscomb as inferences by different potting media have been presented in Table 1 & Fig.5. The analysis submitted significant ($P<0.05$) effect of sowing dates on the plant height; It has been cleared from the data means was found in T_4 (36.55 cm), followed by T_5 (30.71) and statistically similar results observed in the T_1 (23.63 cm), T_2 (24.96 cm) and T_3 (26.03 cm) potting media, respectively. Maximum plant height was observed G2 (51.43 cm) in T_4 and lowest found in T_1 compared to G1 (15.30 cm) potting media. These results are supported by Zeb *et al.* [25] observed plant length of 47cm in gladioulus when planted on 15 September as mid planting time. Obe *et al.* [26] revealed that the sowing dates is one of the methods employed to improve the growth and flower traits of major ornamentals.

3.3. Fresh weight of shoot (FWS)

This study showed average maximum fresh weight of shoot of Cockscomb was the highest found in T_4 (56.40g), followed by the results obtained in T_5 (36.34g). The highest fresh weight of shoot T4 (60.15 g) was observed when the Cockscomb seeds were grown in (T_4) potting medium where only canal silt (100%) was used. In case of genotypes, G2 (36.37 g) and G1 (31.05 g) produced statistically similar fresh weight of shoot presented in Table 2 & Fig. 6. However, interactive effect of the genotypes and potting media was also non-significant and ranges from 14.21 to 60.15 g of fresh weight of shoot. These findings are comparable to the results of Yarnia *et al.* [27] in Amaranth; Kazaz *et al.* [28] in Carnation and Emami *et al.* [29] in *Lilium longiflorium*.

3.4. Fresh weight of root (FWR)

The data (Table 2 & Fig. 7) showed that maximum fresh weight of root of Cockscomb was found in T4 (13.35 g), followed by (10.15 g) obtained in T_5 potting medium. The minimum fresh weight of root (6.25 g) was observed when the Cockscomb plants were grown in (T_1) potting medium where only canal sediments (100%) was used. Maximum fresh weight of root G2 (14.31 g) was observed in (T_4) and lowest found G1 (8.15 g) in the T_1 potting medium. The results are comparable to the findings of Kishan *et al.* [30] and Verma *et al.* [31].

3.5. Fresh weight of a single flower (FWSF)

The results for the single flower weight of Cockscomb under the different potting media have been demonstrated in Table 2 & Fig. 8. On the basis of interaction, the mean fresh weight of a single flower ranges from T_3 (9.27g) to T_4 (20.14g). To compare genotypes (G2) in different potting media had maximum fresh weight of a single flower (16.31 g) in comparison to G1 (10.89 g). Zeb *et al.* [25] reported that 44.29 g of flower weight was obtained when sown on late April. Ismail *et al.* [32] observed that date of planting highly influenced the vegetative and flowering parameters of Tagetes. Baloch *et al.* [33] found that when Cockscomb sown early (Sept-December) flower weight (5.67 g) reduced drastically under low temperature. Blanchard and Runkle [34] found that plants sown above optimum temperature might have produced reduced flowers.

3.6. Days taken to initiate flowering (DTIF)

Present findings of average maximum days taken to initiate flowering of Cockscomb were (52.94) observed in (T_1) potting media and minimum mean days to flowering were observed in T_5 (48.88 days) potting media presented in Table 3 & Fig. 9. To compare genotypes (G2) found maximum means of days to flowering (52.66) in comparison to G1 (47.30 days) and highest results (47.88 days) obtained in (T_4) potting media. The interactive effect of the genotypes and potting media had highly significant differences for days to initiate flowering showed minimum G1 (47.21) days in (T_3) potting media. These findings are in consistence with scientists [35,34] and as confirmed by Baloch et al. [33].

3.7. Number of flowers per plant (NFPP)

Our findings present that maximum number of flowers found G2 (5.05) in (T_4) with the minimum results (2.11) obtained in (T_1) potting medium. Genotypes (G2) had means results (3.79) and G1 (2.97) showed number of flowers presented in Table 3 & Fig. 10. On the basis of interaction, maximum number of flowers G2 (6.66) produced in (T_4) potting media. Production of maximum number of flowers per plant was directly correlated with plant height which was mostly favored by temperature during development. These findings are in consistence with [25,35].

3.8. Electrolyte leakage of leaf (ELL)

The analysis of variance (Table 3 & Fig. 11) revealed that the electrolyte leakage of leaf in Cockscomb vines was significantly influenced by different potting media levels and genotypes while the variation in electrolyte leakage of leaf was not significant ($P>0.05$) for interaction of genotypes × different potting media. Statistical analysis indicates that the maximum means of the potting media ranges from 65.22 to 76.62%. The genotypes had also no differences. Genotypes (G2 and G1) had electrolyte leakage of leaf 73.51 and 70.66%. The interaction of the genotypes and potting media ranges from 63.78 to 78.20%, respectively. These findings are in consistence with [36,37].

3.9. Chlorophyll content of leaf (CCL)

The chlorophyll content of leaf was observed the highest mean in genotypes G2 (33.52) than the G1 (29.80) presented in Table 3 & Fig. 12. Our result had more chlorophyll content found in (T_4) plants of potting media than the rest of treatments. The potting media (T_4) showed the highest 39.58 and 28.75 chlorophyll content of leaf, respectively. The interactive effect of the genotypes and potting media, T_4 medium grown plants had more chlorophyll content of leaf (39.53) in genotype (G2). These findings are in accordance with the findings of Akinfasoye *et al.* [38] in Celosia; Akinfasoye *et al.* [29] similar results were obtained in Kumar *et al.* [39] found in the F_5 populations of *Brassica species*.

4. CONCLUSION

It is concluded that the germination percentage, vegetative and flower characteristics of the Cockscomb genotype G2 (Prestige scarlet) showed maximum performance in T4 (25% Canal sediment + 50% bagasse + 25% Coco peat) the potting media. The Cockscomb genotype G2 (Prestige scarlet) may be choice for achieving superior performance on flowering traits in Tandojam location. Other potting media along with genotypes and geographical locations might be explored for future research activities.

Table 1. Effect of Cockscomb genotypes in response to different potting media.

Tret.	SGP			DGT			GI			PH (cm)		
	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean
T_1	50.00	50.00	50.00c	2.91	3.66	3.29bc	0.78	1.02	0.90b	15.30e	31.96c	23.63c
T_2	58.33	66.67	62.50bc	4.08	4.91	4.50a	0.86	1.23	1.04b	16.16de	33.76c	24.96c
T_3	75.00	75.00	75.00ab	3.50	4.16	3.83ab	1.15	1.19	1.17b	17.06de	35.00c	26.03c
T_4	75.00	100.00	87.50a	2.33	3.00	2.66c	1.6	1.95	1.77a	31.66d	51.43a	36.55c
T_5	66.67	50.00	58.33bc	2.66	3.50	3.08bc	0.93	1.19	1.06b	18.23de	43.20b	30.71
Mean	65.0	68.33		3.10b	3.85a		1.06	1.31		17.68b	39.07a	

G1, Amigo Red; G2, Prestige scarlet; SGP, Seed germination percentage (%); DGT, Days to germination time (days); GI, Germination index; PH, Plant height (cm).

Table 2. Effect of Cockscomb genotypes in response to different potting media.

Tret.	SVI			FWS			FWR			FWSF		
	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean
T_1	765.0e	1528.3cde	1146.7c	14.21	18.60	16.40c	3.55	8.96	6.25c	10.12	13.95	12.03
T_2	949.2e	2250.0bc	1599.6bc	24.25	30.30	27.28bc	6.68	10.87	8.78bc	10.12	15.17	12.64
T_3	1280.0de	2590.0b	1935.0b	29.23	35.05	32.14b	8.33	11.61	9.97b	9.27	14.23	11.75
T_4	1645.0cde	5143.3a	3394.2a	52.65	60.15	56.40a	12.39	14.31	13.35a	13.80	20.14	16.97
T_5	1233.3de	2144.2bcd	1688.8bc	34.92	37.76	36.34b	9.80	10.51	10.15b	11.15	18.06	14.60
Mean	1174.5b	2731.2a		31.05	36.37		8.15b	11.25a		10.89b	16.31b	

G1, Amigo Red; G2, Prestige scarlet; SVI, Seedling vigor index; FWS, Fresh weight of shoot (g); FWR, Fresh weight of root (g); FWSF, Fresh weight of a single flower (g).

Table 3. Effect of Cockscomb genotypes in response to different potting media.

Tret.	DTIF			NFPP			ELL			CCL		
	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean	G1	G2	Mean
T_1	49.11d	56.77a	52.94a	2.33cd	2.29cd	2.11b	70.62	72.36	71.49	24.70e	32.46bc	28.58c
T_2	47.33e	53.33b	50.33b	2.66cd	1.66d	2.16b	74.17	77.22	75.69	29.40cd	28.10de	28.75c
T_3	47.21e	52.55b	49.88bc	2.66cd	2.99cd	2.83b	69.70	73.10	71.40	31.36bcd	34.26b	32.81b
T_4	45.88cd	49.88cd	47.88cd	3.44c	6.66a	5.05a	75.05	78.20	76.62	32.63bc	39.53a	36.08a
T_5	46.99e	50.77c	48.88cd	3.77bc	5.33a	4.55a	63.78	66.66	65.22	30.90bcd	33.26b	32.08b
Mean	47.30b	52.66a		2.97b	3.79a		70.66	73.51		29.80b	33.52a	

G1, Amigo Red; G2, Prestige scarlet; DTIF, Days taken to initiate flowering (days); NFPP, Number of flowers per plant (no.); ELL, Electrolyte leakage of leaf (%); CCL, Chlorophyll content of leaf (%).

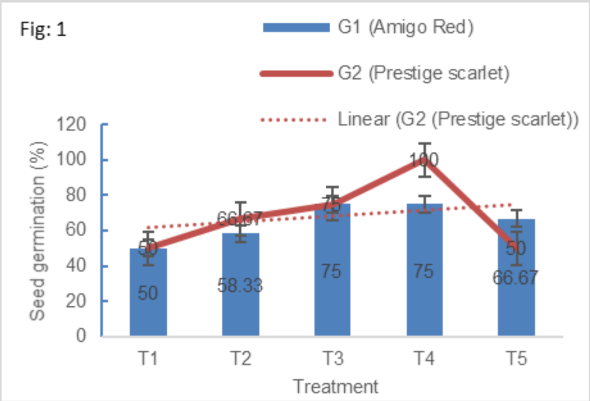
Fig: 1
G1 (Amigo Red)
G2 (Prestige scarlet)
Linear (G2 (Prestige scarlet))
Seed germination (%)
120 100 80 60 40 20 0
50 58.33 75 75 66.67
50 66.67 75 100 50
T1 T2 T3 T4 T5
Treatment

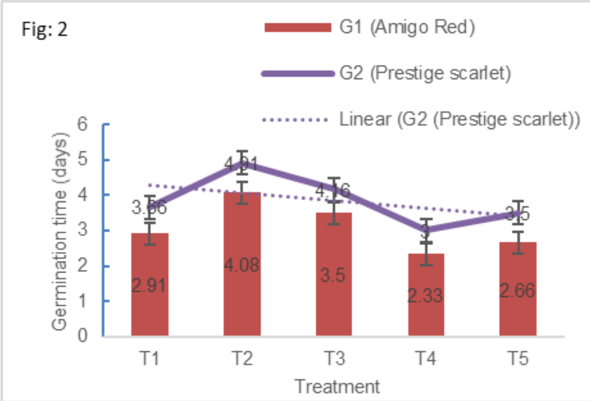
Fig: 2
G1 (Amigo Red)
G2 (Prestige scarlet)
Linear (G2 (Prestige scarlet))
Germination time (days)
6 5 4 3 2 1 0
2.91 4.08 3.5 2.33 2.66
3.66 4.91 4.16 3 3.5
T1 T2 T3 T4 T5
Treatment

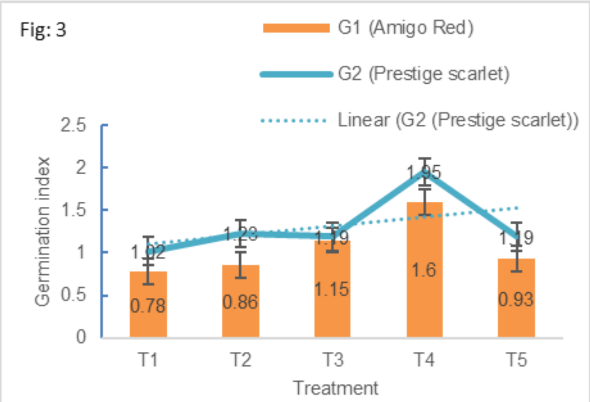
Fig: 3
G1 (Amigo Red)
G2 (Prestige scarlet)
Linear (G2 (Prestige scarlet))
Germination index
2.5 2 1.5 1 0.5 0
0.78 0.86 1.15 1.6 0.93
1.02 1.23 1.19 1.95 1.19
T1 T2 T3 T4 T5
Treatment

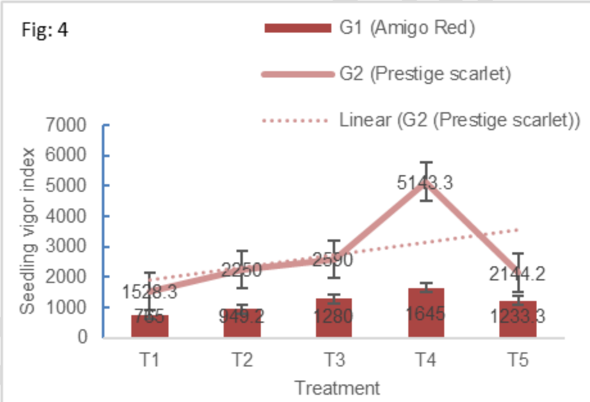
Fig: 4
G1 (Amigo Red)
G2 (Prestige scarlet)
Linear (G2 (Prestige scarlet))
Seedling vigor index
7000 6000 5000 4000 3000 2000 1000 0
765 949.2 1280 1645 1233.3
1528.3 2250 2590 5143.3 2144.2
T1 T2 T3 T4 T5
Treatment

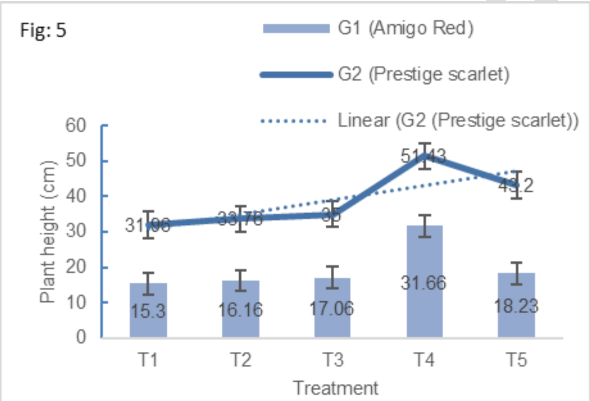
Fig: 5
G1 (Amigo Red)
G2 (Prestige scarlet)
Linear (G2 (Prestige scarlet))
Plant height (cm)
60 50 40 30 20 10 0
15.3 16.16 17.06 31.66 18.23
31.98 33.76 35 51.43 43.2
T1 T2 T3 T4 T5
Treatment

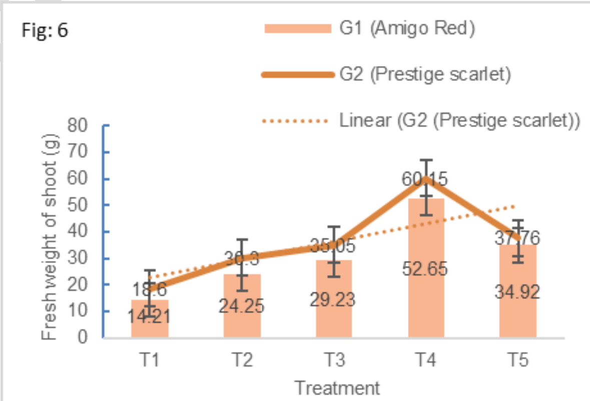
Fig: 6
G1 (Amigo Red)
G2 (Prestige scarlet)
Linear (G2 (Prestige scarlet))
Fresh weight of shoot (g)
80 70 60 50 40 30 20 10 0
14.21 24.25 29.23 52.65 34.92
18.6 30.3 35.05 60.15 37.76
T1 T2 T3 T4 T5
Treatment

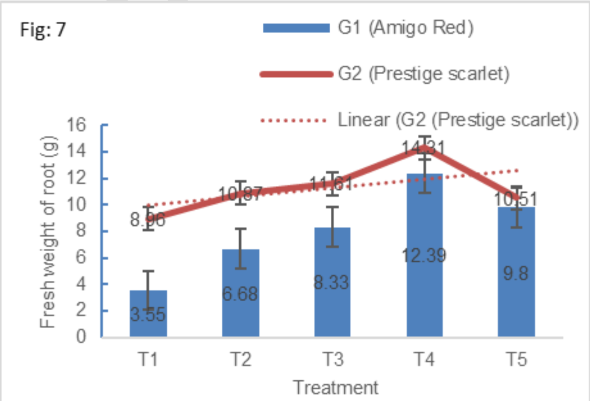
Fig: 7
G1 (Amigo Red)
G2 (Prestige scarlet)
Linear (G2 (Prestige scarlet))
Fresh weight of root (g)
16 14 12 10 8 6 4 2 0
3.55 6.68 8.33 12.39 9.8
8.96 10.87 11.61 14.21 10.51
T1 T2 T3 T4 T5
Treatment

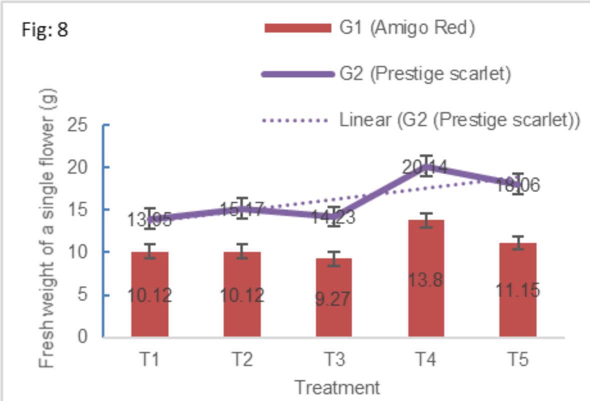
Fig: 8
G1 (Amigo Red)
G2 (Prestige scarlet)
Linear (G2 (Prestige scarlet))
Fresh weight of a single flower (g)
25 20 15 10 5 0
10.12 10.12 9.27 13.8 11.15
13.95 15.17 14.23 20.14 18.06
T1 T2 T3 T4 T5
Treatment

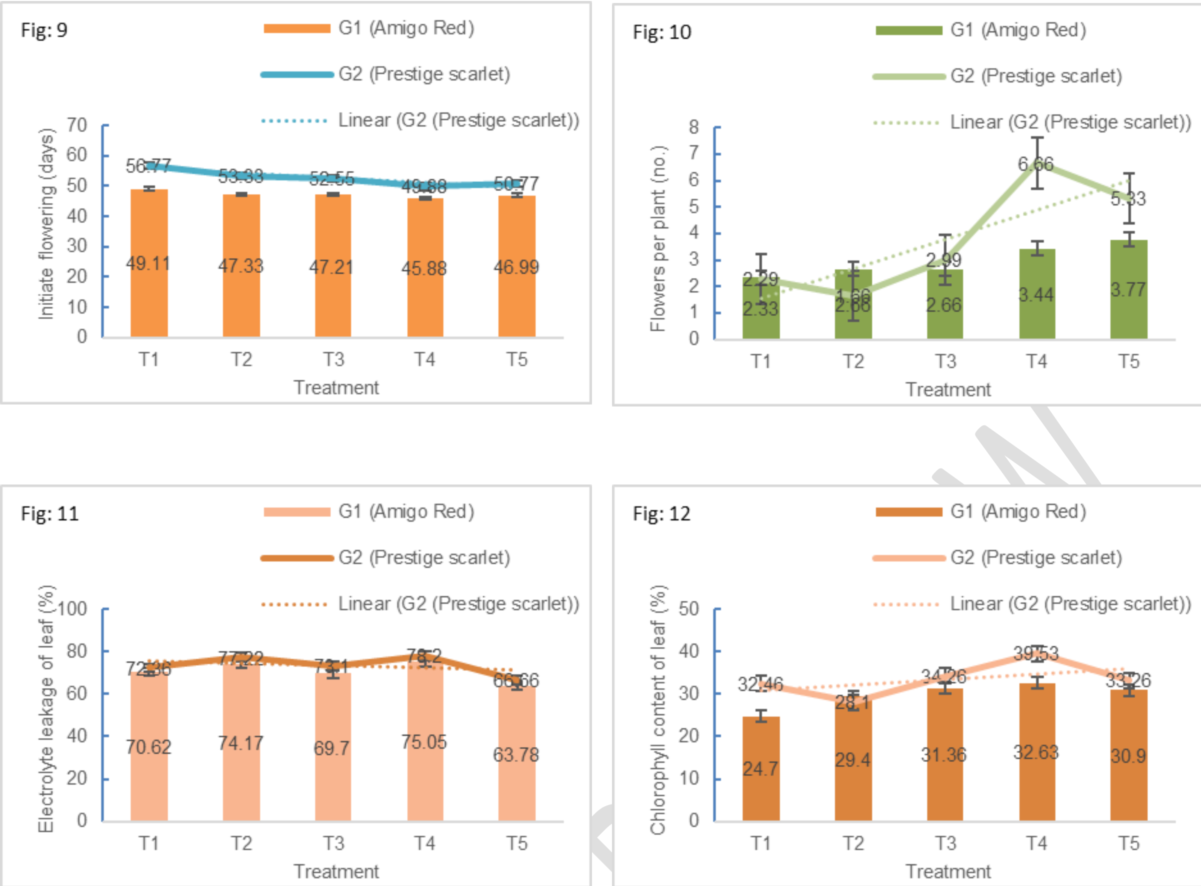

Fig. 1-12: Histogram showing germination characterization

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