Seed priming and media for enhanced seedling growth in pansy (*Viola tricolor*)

Abstract

The alarming increase of temperature in Northern areas of India makes it difficult to grow seeds due to these temperature fluctuations. Since Punjab is the hub of annual flower seed production it becomes imperative to identify suitable seed primming and growing media for proper growth and germination of seedlings of annual flower crops. Hence this investigation was conducted in PAU, Ludhiana to evaluate different pre sowing seed treatment and growing media in pansy seeds for better growth and development of seedlings. The maximum shoot length (5.75cm), root length (5.38 cm), number of leaves (8.00), fresh weight (14.04g), dry weight (1.42 g) and SPAD index (34.43) was recorded through synergistic effect of GA_3 @ 25 ppm + soil: cocopeat: vermicompost (1:1:1) in pansy. Therefore, it was concluded from the study that treatment combination of GA_3 @ 25 ppm + soil: cocopeat: vermicompost (1:1:1) was found to be the best for almost all parameters as compared to the other treatments.

Key words: *Viola tricolor*, pansy, growing media, seed treatment, cocopeat.

INTRODUCTION

Pansy (*Viola tricolor*) considered as most vibrant and commonly grown winter annual. It belongs to the family Violaceae and is native of cooler parts of Europe (Post, 1949). It is commonly called as 'the flower of all seasons' and is cultivated as bedded and pot plant (Startek, 2003). The name "pansy" originated from French word "pensee" meaning "thought" and evolved to denote love thoughts. The flower is 5 to 8 cm in diameter and has two slightly overlapping upper petals, two side petals and a single bottom petal with a slight beard emanating from the flower's centre.

The most specific problems concerned with pansy cultivation is that the seeds are difficult to germinate and there is lack of suitable media. This problem produces unbalanced seedling growth and further affects the performance of plants in terms of growth, branching, less flower and seed yield (Roa and Philipse, 1993). There is a large difference between the seeds sown and availability of healthy seedlings as germination goes below 40% and available seedlings for planting are only 30-40% (Kessler, 1998). This cause monetary losses to the growers because of costly pansy seeds especially F_1 hybrids. The germination percentage can be maximized up to 80 to 85% by using the best technologies. Hence, there is an urgent need to use some techniques for improving seed germination qualities and production of healthy seedlings of pansy.

One such method of improving the seed quality is giving pre-sowing controlled seed treatment (Priming) i.e. hydration followed by re-drying in controlled conditions. It improves seed germination percentage, rate, time and quality of seedlings especially under adverse conditions (Nawaz et al. 2013). The nursery media plays a significant role for seed germination and affects the quality of seedlings (Startek, 2003). Different rooting media can be used to grow pansy seedlings while the chemical and physical properties of medium like pH, texture, structure as well as N, P, K are dominant factors for development and growth of plant (Riaz et al. 2008).

The use of seed treatment techniques and growing media compositions will be very economical for the seed companies in terms of high returns as a result of improved germination values and production of better seedlings. Thus, realizing the importance of pansy at commercial level, there is need to investigate the effect of seed priming and media to improve the seedling growth for production of healthy seedlings.

MATERIAL AND METHODS

The present investigation was carried out during the year 2020-21 at Research Farm of Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana, Punjab. The seeds were given pre sowing treatment for 24 hours with control/water (T_1), Thiourea @ 50 ppm (T_2), KNO_3 @ 0.1% (T_3), KNO_3 @ 0.2% (T_4), GA_3 @ 25 ppm (T_5), GA_3 @ 50 ppm (T_6) and GA_3 @ 75 ppm (T_7) and sown in plug trays in October as per different media compositions i.e. soil: FYM (1:1; M_1), soil: sand: vermicompost (1:1:1; M_2), soil: sand: FYM (1:1:1; M_3), soil: sand: leaf manure (1:1:1; M_4), soil: cocopeat: vermicompost (1:1:1;

M_5) and soil: leaf manure (1:1; M_6). The experiment was laid out in factorial CRD design with three replications per treatment. The data on various seedlinggrowth parameters were recorded and analysed using SAS software and treatment means were compared using DMRT (Duncan Multiple Range Test) at 5% level of significance (Duncan, 1955). The data was calculated by using formulas given below-

1. **Moisture content (%):** The moisture content of seedlings was calculated by using following formula:

$$\text{Moisture content } \% = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100$$

2. **Dry matter (%):** Dry matter percentage was calculated by subtracting the moisture content from 100%.

Dry matter % = 100% - Moisture content

Result and discussion

The effect of pre-sowing seed treatment and media on seedling growth parameters of pansy i.e. shoot length, number of leaves per seedling, SPAD index,root length, root: shoot ratio, fresh weight of seedlings, dry weight of seedlings, moisture content percentageand dry matter percentage was recorded to be significant ($p<0.05$) (Table 1 and 2).

Among pre sowing seed treatments, the seeds of pansy treated with GA_3 @ 25 ppm recorded maximum shoot length (5.00cm), number of leaves (7.28), SPAD index (33.08), root length (4.79cm), fresh weight (12.94g)and dry weight (1.31 g). The highest dry matter percentage was recorded in KNO_3 @ 0.2% (10.41%) and found to be significantly different from other treatments. In case of moisture content percentage was significantly recorded in Thiourea @ 50 ppm (90.05%) followed by GA_3 @ 25 ppm (89.87%) which were at par.

Among media treatments minimum shoot length (5.04cm), number of leaves (7.24), SPAD index (33.53),root length (4.96cm), fresh weight (12.33g), dry weight (1.24g)andmoisture content percentage (89.95%) was recorded under soil: cocopeat:

vermicompost (1:1:1) in pansy. The equal ratio of soil: sand: vermicompost (10.33%) reported significantly highest dry matter percentage, whereas lowest percentage was observed in equal ratio of soil: cocopeat: vermicompost (10.05%).

Among seed treatment x media interaction, maximum shoot length (5.75cm), number of leaves (8.00), SPAD index (34.43),root length (5.38cm), fresh weight (14.04g)and dry weight (1.42g) was recorded in GA_3 @ 25 ppm + soil: cocopeat: vermicompost (1:1:1) in pansy.Among seed treatment x media interaction, KNO_3 @ 0.2% + equal proportion of soil: sand: leaf manure (11.09%) recorded significantly highest dry matter percentage. The maximum significant moisture content percentage (90.23%) was observed in GA_3 @ 50 ppm + soil: sand: leaf manure (1:1:1) followed by KNO_3 @ 0.2% + soil: leaf manure (1:1) and KNO_3 @ 0.1% + soil: cocopeat: vermicompost (1:1:1) which were at par.

In this study pre-sowing treatment with gibberellic acidespecially GA_3 @ 25 ppm significantly enhanced subsequent seedling growth in pansy viz. shoot and root length, number of leaves per seedling, fresh and dry weight of seedlings and SPAD index in pansy. This may be due to the positive effects of GA_3in enhancement of cell division and enlargement in cambium tissue(Parab et al.2017). Similar results were reported in annual chrysanthemum by Thakuret al.(2022)and in marigold by Kumar et al.(2020). The higher fresh and dry weight in GA_3 treatments is chiefly because of increased mobilization of water, membrane permeability, nutrient uptake and transport which leads to higher production of photosynthesis products (Parab et al.2017, Harsha et al.2017). GA_3 increases Ca^{2+} ion in the leaf cells which help to keep water balance and maintain high RWC of leaf (Ali et al.2012). This accelerates root and shoot length, fresh and dry weight and increases leaf water content as earlier reported by Shahzad et al.(2014). GA_3also increases the somatic absorption of nutrients, which leads to cell elongation and thus increases the main root length and the number of secondary roots.

The medium with vermicompost and cocopeat is more suitable because of better physical properties and enhanced nutrient level, provides a better growth medium for plant establishment(Campos Mota et al.2009, Abirami et al.2010). This treatment combination due to proper aeration in the root zone of the seedling producesbetter quality seedlings. The improved seedling growth observed in media containing soil, cocopeat and vermicompost (1:1:1) can also be attributed to several factors such as optimal highest water holding capacity (220.10%), total porosity (80%), ideal total nitrogen percentage (0.12%), available phosphorus percentage (0.61%) and available potassium percentage (1.95%) facilitating superior performance across all traits (Fig 1.).

Conclusion

Thus overall, it was observed that the best seed treatment for raising seedlings in pansy was GA_3 @ 25 ppm and best media was soil: cocopeat: vermicompost (1:1:1). Among the seed treatment x media interaction, treatment comprised of GA_3 @ 25 ppm + soil: cocopeat: vermicompost (1:1:1) was found to be the best for almost all parameters as compared to the other treatments.

Table 1: Individual effect ofseed priming and media on seedling growth traits in

pansy(*Viola tricolor*)

Treatments	Shoot length (cm)	No. of leaves per plant	SPAD index	Root length (cm)	Root: shoot ratio	Fresh weight (g)	Dry weight (g)	Moisture content	Dry matter
T_1 (Water or control)	4.17 ^{F}	5.67 ^{D}	31.55 ^{E}	4.22 ^{E}	0.99 ^{C}	8.33 ^{F}	0.86 ^{E}	89.67 ^{BC}	10.32 ^{AB}
T_2 (Thiourea @ 50 ppm)	4.47 ^{E}	5.95 ^{CD}	31.61 ^{E}	4.40 ^{D}	1.02 ^{B}	8.54 ^{E}	0.85 ^{E}	90.05 ^{A}	9.99 ^{C}
T_3 (KNO_3 @ 0.1%)	4.52 ^{D}	6.06 ^{B}	32.30 ^{D}	4.44 ^{CD}	1.02 ^{B}	12.74 ^{D}	1.14 ^{D}	89.74 ^{BC}	10.27 ^{AB}
T_4 (KNO_3 @ 0.2%)	4.65 ^{C}	6.72 ^{B}	32.52 ^{C}	4.53 ^{BC}	1.03 ^{AB}	11.50 ^{C}	1.20 ^{C}	89.59 ^{C}	10.41 ^{A}
T_5 (GA_3 @ 25 ppm)	5.00 ^{A}	7.28 ^{A}	33.08 ^{A}	4.79 ^{A}	1.04 ^{A}	12.94 ^{A}	1.31 ^{A}	89.87 ^{A}	10.13 ^{BC}
T_6 (GA_3 @ 50ppm)	4.84 ^{B}	7.22 ^{A}	32.80 ^{B}	4.69 ^{A}	1.04 ^{AB}	12.80 ^{A}	1.29 ^{AB}	89.89 ^{AB}	10.10 ^{BC}
T_7 (GA_3 @ 75ppm)	4.61 ^{C}	6.67 ^{B}	32.20 ^{D}	4.55 ^{B}	1.01 ^{B}	12.43 ^{B}	1.27 ^{B}	89.75 ^{AB}	10.25 ^{AB}
Media									
M1: Soil: FYM (1:1)	4.33 ^{E}	5.86 ^{C}	31.23 ^{F}	4.30 ^{D}	1.01 ^{B}	10.43 ^{D}	1.07 ^{D}	89.74 ^{AB}	1.07 ^{D}
M2= Soil: sand: vermicompost (1:1:1)	4.54 ^{C}	6.33 ^{B}	31.73 ^{E}	4.41 ^{C}	1.03 ^{AB}	11.12 ^{C}	1.15 ^{C}	89.67 ^{B}	1.15 ^{C}
M3= Soil: sand: FYM (1:1:1)	4.45 ^{D}	6.29 ^{B}	31.96 ^{D}	4.42 ^{C}	1.01 ^{B}	10.56 ^{D}	1.08 ^{D}	89.81 ^{AB}	1.08 ^{D}
M4= Soil: sand: leaf manure (1:1:1)	4.45 ^{D}	6.38 ^{B}	32.31 ^{C}	4.37 ^{CD}	1.02 ^{B}	10.42 ^{D}	1.07 ^{D}	89.74 ^{AB}	1.07 ^{D}
M5= Soil: cocopeat: vermicompost (1:1:1)	5.04 ^{A}	7.24 ^{A}	33.53 ^{A}	4.96 ^{A}	1.02 ^{B}	12.33 ^{A}	1.24 ^{A}	89.95 ^{A}	1.24 ^{A}
M6= Soil: leaf manure (1:1)	4.85 ^{B}	6.95 ^{A}	32.99 ^{B}	4.64 ^{B}	1.04 ^{A}	11.73 ^{B}	1.19 ^{B}	89.84 ^{AB}	1.19 ^{B}

Table 2: Combined effect of seed priming and media on seedling growth traits in

pansy(*Viola tricolor*)

Media and seed priming	Shoot length (cm)	No. of leaves per plant	SPAD index	Root length (cm)	Root: shoot ratio	Fresh weight (g)	Dry weight (g)	Moisture content	Dry matter
T_1M_1	3.98^{r}	4.33^{f}	30.00^{p}	4.08^{h}	0.98^{b}	7.95^{t}	0.85^{m}	89.27^{ab} (70.88)	0.85^{m}
T_1M_2	4.07^{r}	5.67^{f}	30.17^{p}	4.07^{h}	1.00^{ab}	8.21^{t}	0.89^{m}	89.15^{ab} (70.77)	0.89^{m}
T_1M_3	4.15^{r}	5.67^{f}	31.97^{m}	4.33^{h}	0.96^{b}	7.82^{t}	0.78^{m}	89.99^{ab} (71.55)	0.78^{m}
T_1M_4	4.14^{r}	5.33^{f}	32.10^{l}	4.11^{h}	1.01^{ab}	7.69^{t}	0.79^{m}	89.77^{ab} (71.43)	0.79^{m}
T_1M_5	4.37^{o}	6.67^{e}	32.93^{i}	4.43^{h}	0.99^{ab}	9.32^{q}	0.94^{l}	89.95^{ab} (71.52)	0.94^{l}
T_1M_6	4.30^{p}	6.33^{e}	32.17^{l}	4.28^{h}	1.01^{ab}	8.97^{r}	0.90^{m}	89.93^{ab} (71.50)	0.90^{m}
T_2 M1	4.14^{r}	5.00^{f}	30.30^{p}	4.06^{h}	1.02^{ab}	7.90^{t}	0.79^{m}	90.01^{ab} (71.57)	0.79^{m}
T2M2	4.55^{m}	6.00^{f}	30.57^{p}	4.43^{h}	1.03^{ab}	8.59^{s}	0.86^{m}	89.99^{ab} (71.56)	0.86^{m}
T2M3	4.47^{o}	5.67^{f}	31.50^{n}	4.33^{h}	1.03^{ab}	7.93^{t}	0.79^{m}	90.03^{ab} (71.60)	0.79^{m}
T2M4	4.37^{o}	6.00^{f}	32.13^{l}	4.31^{h}	1.01^{ab}	7.89^{t}	0.78^{m}	90.08^{a} (71.64)	0.78^{m}
T2M5	4.70^{i}	6.67^{e}	32.73^{j}	4.75^{e}	0.99^{ab}	9.88^{p}	0.96^{k}	90.28^{ab} (71.84)	0.96^{k}
T2M6	4.61^{k}	6.33^{e}	32.40^{k}	4.51^{h}	1.02^{ab}	9.03^{q}	0.93^{m}	89.70^{ab} (71.28)	0.93^{m}
T_3 M1	4.27^{q}	5.67^{f}	31.00^{o}	4.18^{h}	1.02^{ab}	10.36^{o}	1.07^{j}	89.71^{ab} (71.29)	1.07^{j}
T3M2	4.49^{o}	6.00^{f}	32.27^{l}	4.44^{h}	1.01^{ab}	11.25^{m}	1.15^{h}	89.74^{ab} (71.32)	1.15^{h}
T3M3	4.37^{o}	5.67^{f}	31.30^{n}	4.33^{h}	1.01^{ab}	10.62^{o}	1.11^{i}	89.55^{ab} (71.14)	1.11^{i}
T3M4	4.33^{p}	5.67^{f}	32.33^{k}	4.26^{h}	1.02^{ab}	10.26^{o}	1.07^{j}	89.58^{ab} (71.16)	1.07^{j}
T3M5	4.93^{e}	6.67^{e}	33.60^{d}	4.90^{d}	1.01^{ab}	12.46^{j}	1.24^{g}	90.07 a (71.64)	1.24^{g}
T3M6	4.72^{h}	6.67^{e}	33.27^{f}	4.54^{h}	1.04^{ab}	11.95^{l}	1.22^{g}	89.76^{ab} (71.34)	1.22^{g}
T4 M1	4.37^{o}	6.00^{f}	31.87^{m}	4.40^{h}	0.99^{ab}	10.71^{n}	1.13^{h}	89.48^{ab} (71.07)	1.13^{h}
T4 M2	4.55^{m}	6.33^{e}	32.07^{l}	4.47^{h}	1.02^{ab}	11.35^{m}	1.18^{h}	90.08^{a} (71.64)	1.18^{h}
T4 M3	4.51^{n}	7.00^{d}	32.03^{l}	4.38^{h}	1.03^{ab}	10.40^{o}	1.07^{j}	89.58^{ab} (71.16)	1.07^{j}
T4 M4	4.49^{o}	6.67^{e}	32.20^{l}	4.32^{h}	1.04^{ab}	10.71^{n}	1.19$_{h}$	88.91^{b} (70.54)	1.19$_{h}$
T4 M5	5.05^{d}	7.33^{c}	33.83^{c}	4.98^{c}	1.02^{ab}	13.11^{f}	1.34^{c}	89.75^{ab} (71.33)	1.34^{c}

T4 M6	4.92 ^{f}	7.00 ^{d}	33.10 ^{h}	4.63 ^{f}	1.06 ^{ab}	12.73 ^{i}	1.26 ^{f}	90.08 ^{a} (71.64)	1.26 ^{f}
T5 M1	4.66 ^{j}	6.67 ^{e}	32.23 ^{l}	4.49 ^{h}	1.04 ^{ab}	12.22 ^{j}	1.24 ^{g}	89.83 ^{ab} (71.40)	1.24 ^{g}
T5M2	4.93 ^{e}	7.00 ^{d}	32.57 ^{j}	4.66 ^{f}	1.06 ^{ab}	13.02 ^{g}	1.33 ^{d}	89.81 ^{ab} (71.38)	1.33 ^{d}
T5M3	4.65 ^{j}	7.00 ^{d}	32.53 ^{j}	4.58 ^{g}	1.01 ^{ab}	12.68 ^{i}	1.29 ^{e}	89.80 ^{ab} (71.37)	1.29 ^{e}
T5M4	4.71 ^{h}	7.33 ^{c}	33.20 ^{g}	4.65 ^{f}	1.01 ^{ab}	12.22 ^{j}	1.23 ^{g}	89.93 ^{ab} (71.50)	1.23 ^{g}
T5M5	5.75 ^{a}	8.00 ^{a}	34.43 ^{a}	5.38 ^{a}	1.07 ^{ab}	14.04 ^{a}	1.42 ^{a}	89.86 ^{ab} (71.43)	1.42 ^{a}
T5M6	5.32 ^{b}	7.67 ^{b}	33.50 ^{e}	4.99 ^{c}	1.07 ^{ab}	13.44 ^{d}	1.35 ^{c}	89.98 ^{ab} (71.54)	1.35 ^{c}
T6 M1	4.52 ^{m}	7.00 ^{d}	31.93 ^{m}	4.44 ^{h}	1.02 ^{ab}	12.11 ^{k}	1.21 ^{h}	90.03 ^{ab} (71.60)	1.21 ^{h}
T6M2	4.77 ^{g}	6.67 ^{e}	32.40 ^{k}	4.41 ^{g}	1.09 ^{a}	13.10 ^{g}	1.35 ^{c}	89.72 ^{ab} (71.30)	1.35 ^{c}
T6M3	4.62 ^{k}	7.00 ^{d}	32.40 ^{k}	4.58 ^{g}	1.01 ^{ab}	12.35 ^{j}	1.24 ^{g}	89.96 ^{ab} (71.53)	1.24 ^{g}
T6M4	4.59 ^{l}	7.33 ^{c}	32.40 ^{k}	4.55 ^{h}	1.01 ^{ab}	12.10 ^{k}	1.18 ^{h}	90.23 ^{a} (71.78)	1.18 ^{h}
T6M5	5.37 ^{b}	8.00 ^{a}	34.07 ^{b}	5.27 ^{a}	1.02 ^{ab}	13.89 ^{b}	1.42 ^{a}	89.75 ^{ab} (71.33)	1.42 ^{a}
T6M6	5.18 ^{c}	7.33 ^{c}	33.57 ^{d}	4.90 ^{d}	1.06 ^{ab}	13.24 ^{e}	1.36 ^{b}	89.70 ^{ab} (71.28)	1.36 ^{b}
T7 M1	4.34 ^{p}	6.33 ^{e}	31.30 ^{n}	4.43 ^{h}	0.98 ^{ab}	11.74 ^{l}	1.19 ^{h}	89.86 ^{ab} (71.43)	1.19 ^{h}
T7M2	4.41 ^{o}	6.67 ^{e}	32.03 ^{l}	4.39 ^{h}	1.00 ^{ab}	12.31 ^{j}	1.27 ^{f}	89.70 ^{ab} (71.28)	1.27 ^{f}
T7M3	4.38 ^{o}	6.00 ^{f}	32.00 ^{l}	4.40 ^{h}	1.00 ^{ab}	12.10 ^{k}	1.26 ^{g}	89.59 ^{ab} (71.18)	1.26 ^{g}
T7M4	4.51 ^{n}	6.33 ^{e}	31.83 ^{m}	4.42 ^{h}	1.02 ^{ab}	12.06 ^{k}	1.24 ^{g}	89.69 ^{ab} (71.27)	1.24 ^{g}
T7M5	5.08 ^{d}	7.33 ^{c}	33.10 ^{h}	5.01 ^{b}	1.01 ^{ab}	13.59 ^{c}	1.36 ^{b}	89.97 ^{ab} (71.53)	1.36 ^{b}
T7M6	4.92 ^{f}	7.33 ^{c}	32.93 ^{i}	4.66 ^{f}	1.06 ^{ab}	12.78 ^{h}	1.32 ^{d}	89.70 ^{ab} (71.28)	1.32 ^{d}

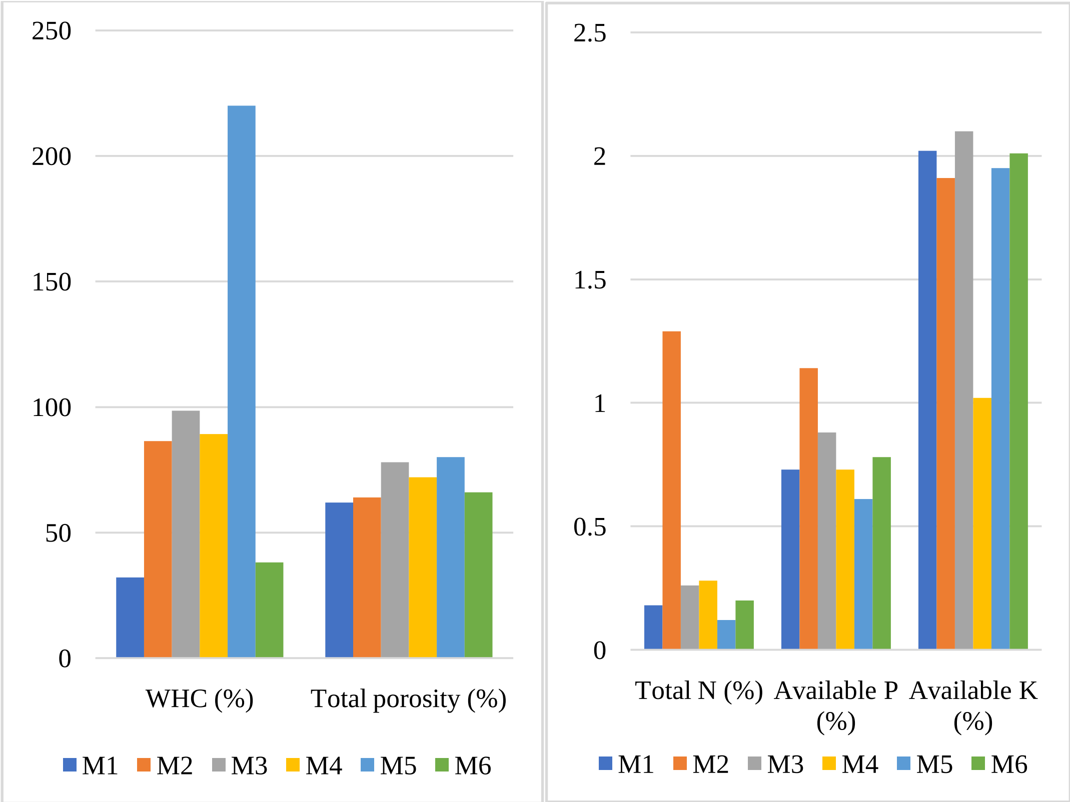

Fig 1. Media analysis for different physical and chemical properties

References

Abirami K Rema JMathew PA, Srinivasan Vand HamzaS.Effect of different propagation media on seed germination, seedling growth and vigour of nutmeg (*Myristica fragrans* Houtt.). *J Med Plants Res*.2010;4(19): 2054-58.

Ali HM, Siddiqui MH, Basalah MO, Al-Whaibi MH, SakranAM and Al-AmriA. Effects of gibberellic acid on growth and photosynthetic pigments of *Hibiscus sabdariffa* L. under salt stress. *Afr J Biotechnol*. 2012;11: 800-04.

Campos Mota L, Van Meeteren U and Blok C.Comparison of physical properties of vermicompost from paper mill sludge and green compost as substitutes for peat based potting media. *Acta Hort*. 2009;819: 227-34.

Duncan DB. Multiple range and multiple F tests. *Biometrics* 1955;11: 1-42.

Harsha HR, RaoV, Dayamani KJ and ShivannaM. Pummelo (*Citrus maxima* Merill) seedlings growth as influenced by plant growth regulators and macronutrients. *Int J Curr Microbiol App Sci*. 2017;6(12): 1750-54.

Kessler JR, Hagan JA and Cobb P.Pansy production and marketing. Alabama A&M and Auburn Universities. ANR, 1998; p 596.

Kumar P, Singh A, Laishram N, Pandey RK, Dogra S, Jeelani MI and SinhaBK Effects of plant growth regulators on quality flower and seed production of marigold (*Tagetes erecta* L.). *Bangladesh J Bot.* 2020;49(3): 567-77.

Nawaz J, Hussain M, Jabbar A, Nadeem GA, SajidM, Subtain Mand ShabbirI. Seed priming a technique. *Int J Agri Crop Sci.*2013;6: 1373-81.

Parab AM, Mathad JCand MalsheKV. Effect of presoaking chemicals on germination and subsequent seedling growth of papaya (*Carica papaya*) Cv. Solo. *IJCS* 2017;5(4): 1812-16.

Post K. Florist crop production and marketing. *Orange Fudd*. 1949;33-35.

Riaz A, Arshad M, Younis A, RazaA,and HameedM. Effect of different growing media on the growth and flowering of *Zinnia elegans* cv. Blue Point. *Pak J Bot*. 2008;40: 1579-85.

Roa S and Philipse W. Effect of seed priming and soil residue on seeding emergence and forage production of Brassicas. *J Sust Agric*1993;3: 89-98.

Shahzad R, KhanJ, GurmaniAR, WaqasM, Hamayun M,Khan AL,Kang SM and LeeIJ. Seed priming with gibberellic acid (GA_3) in sponge-gourd modulated high salinity stress. *J Life Sci.*2014;02: 75-86.

Startek L. Cultivation facilities and decorative value of garden pansy. *Rośliny Ozdobne*2003;2: 16-18.

Thakur T, Singh Nand GargA. Seed germination and seedling growth of annual chrysanthemum (*Glebionis coronaria* L). as influenced by priming and growing media.*CAAS*2022;14: 170-174.