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NUTRIENT UPTAKE, GROWTH, YIELD AND QUALITY OF CUCUMBER GROWN IN VARIOUS GROWING MEDIA

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ABSTRACT

Different substrates, namely, spent mushroom compost (SMC), press mud (PM), farmyard manure (FYM), non-granular compost (NGC), granular compost (GC), and silt were used alone or in different combinations to assess their impact on seedling production of cucumber variety "Summer Green" and its further growth, yield, and quality. The highest germination rate (93%) was observed in the mixtures of 75%:25% and 50%:50% silt and PM, 25%:75% silt and FYM, and 50%:50% silt and NGC, about five times higher than control (20%). Shoot length (4.5cm), root length (14.0cm), number of lateral branches (6.8), chlorophyll contents (105.9), and fresh seedling weight (5.3g) was highest in the mixture of 50%:50% silt and NGC, around 1.9, 1.5, 2.5 and 2.8 times higher than that of control, respectively. But highest dry weight (30.9mg) was recorded in the mixture of 50%:50% silt and SMC, almost 2.5 times greater than that of control (12.4mg). While the number (3.5) and weight (1388.4g) of fruits plant-1, fruit diameter (62.11mm), fruit length (25.3cm) and leaf nitrogen (0.7mg/g dry sample), and potassium (27.5mg/g dry sample), Total soluble solids (TSS) (Brix) and phenolic contents (55.5mg GAE 100g-1) were also the highest in the mixture of 50%:50% silt and NGC. Correlation revealed significant positive relation of germination with growth and yield-related traits. The above results show that the mixture of silt and NGC (50%:50%) can be used as a local media for cucumber seedling production. Further studies are needed to compare this local media as a substitute for peat moss, using some other cucurbits.

***Keywords*:** *Cucumis sativus*, Compost, Farmyard manure, Fruit yield, Press mud, Seedlings, Silt, Total phenolics

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1. INTRODUCTION

Cucumber stands fourth among economically important vegetables on the globe after tomato, cabbage, and onion. Worldwide acreage of cucumber was 2.231 million hectares and production were 87.805 million tons. Its production in Pakistan was 77.57 thousand tons from 3.577 thousand hectares (FAOSTAT 2019). The need for renewable energy and decreased cost of fertilization, have revived the use of organic materials (Pascual et al. 2018). The peat moss is a purely non-renewable media and its use as a growing medium to produce transplants is too expensive as it is imported, and its price increases every year **(**Pascual et al. 2018**)**. There is a dire need to replace the peat moss with a local material that has many of the desirable characteristics of peat moss and is cheaper (Ahmad et al. 2020). Use of coccoir and rice hulls in growing media has gained popularity during last decades. Tomato plants grown in coco-coir and rockwool showed statistically similar fresh and dry weight values, but highest values of these parameters were recorded for media containing perlite and carbonized rice hulls (Inden and Torres 2004).

The use of compost as growing media affects transplant's growth and nutrient contents (Nair et al. 2011). Several composts have been reported to display comparable results with peatmoss, *viz.* compost from sewage mud, solid waste of municipalities (Perez-Murcia et al. 2006), animal manure (Ribeiro et al. 2007), media used for mushroom production (Chellemi and Lazarovits 2002) and waste from agriculture-based industries (Bustamante et al. 2008). Combination of vermicompost: garden soil (1:9) with 2cm layer of coco-coir produced high yield of good quality cucumber grown in polyhouse (Lata et al. 2018). While Janapriya et al. (2010) obtained highest yield of cucumber in media having vermicompost, peat and sand. However, Al-Far et al. (2019) reported that media containing Tuff and 50% sawdust was cheapest compared to other media in which perlite was used and produced high yield of seedless cucumber cultivar. On the other hand, Albaho et al. (2013) reported high level of vegetative and reproductive growth as well fruit quality of cucumber cv. Banan in two media containing peatmoss (35%) + perlite (40%) +

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vermicompost (25%) and peatmoss (35%)+ perlite (40%)+ vermicompost (25%)+ coco-peat (25%). Sarwar et al. (2018) recommended media containing silt:leaf compost:perlite in 1:1:1 ratio for kitchen gardening of cucumber.

But use of media based on agricultural wastes will be more promising, cheap, eco-friendly and sustainable approach compared to other combinations using imported materials such as peatmoss, vermiculite and perlite. This article reports the impact of various proportions of different agricultural wastes on growth, yield and quality of cucumber.

2. MATERIALS AND METHODS

This trial was executed at vegetable research farm of Institute of Horticultural Sciences, University of Agriculture, Faisalabad. Impact of different locally available substrates on cucumber seedling production and yield as well as quality was assessed. Substrates used were, silt, press mud, spent mushroom compost, FYM and commercially available compost (in Granular and non-granular form containing ≥25% organic matter), a product of RMA Enterprises Faisalabad, in various combinations: Control=100% silt; Silt + Spent mushroom compost (SMC) (75:25); Silt + SMC (50:50); Silt + SMC (25:75); Silt + Press mud (PM) (75:25); Silt + PM (50:50); Silt + PM (25:75); Silt+ farm yard manure (FYM) (75:25); Silt + FYM (50:50); Silt+ FYM (25:75); Silt + non-granular compost (NGC) (75:25); Silt + NGC (50:50); Silt + NGC (25:75); Silt + granular compost (GC) (25:75); Silt + GC (50:50); Silt + GC (75:25). Seeds of cucumber variety 'Summer Green' were purchased from Sadique Sons, Dijkot Road, Faisalabad. Seed sowing was done on September 26, 2015. Three seeds were sown in poly pack (punctured for drainage) containing above mentioned media. Poly packs were irrigated after seed sowing; Later on irrigation was done as per need. Four poly packs containing anyone of the abovementioned media were considered as replication and there were four replications of each treatment. Treatments were arranged according to completely randomized design.

2.1. Data Recording

2.1.1. Seedling traits

The number of emerged seedlings was counted after seven days of sowing to calculate the emergence percentage. After 14 days, data were recorded for seedling traits. Root and shoot length of five seedlings selected at random from each replication was determined by using scale and mean value was calculated. Three selected seedlings from each replication were weighed for fresh weight determination and average was calculated. These seedlings were oven dried at 70°C till constant dry weight.

2.2. Yield related traits

Total number of fruits and yield per plant was recorded from five plants in each replication. At the time of last harvesting of cucumber fruit, total number of lateral branches were counted from five randomly selected plants. Length and diameter of five fruits per replication was measured at marketable maturity stage with the help of Vernier caliper.

2.3. Nutrient contents and Biochemical parameters

Nitrogen, phosphorus, and potassium were determined using the method described by Carter and Gregorich (2008). Leaf chlorophyll content was determined using the digital SPAD meter (SPAD-502). Total soluble solids of cucumber fruit juice were ascertained through a digital refractometer (ATAGO, RS-5000, Japan) at room temperature and expressed as Brix. Total phenolic contents of fruit were assayed as described by Ribeiro et al. (2007).

2.4. Statistical Analysis

Data were analyzed in computer-based software "Statistix 8.1" using ANOVA and statistical difference among treatments was determined using least significant difference test at 5% probability level. Correlation analysis was performed in R-Program.

3. RESULTS AND DISCUSSION

3.1. Growth parameters

The mixtures of silt and press mud (PM) in a proportion of 75%:25% and 50%:50%, silt and farmyard manure (FYM) in a proportion of 75%:25%, and silt and granular compost (GC) in a proportion of 50%:50% had the highest germination percentage (93%) (Fig. 1a). The control, in comparison, showed only 30.5% germination (Fig. 1a). Previously, Manolova et al. (2015) also observed two- and 1.5-times higher germination percentage of *Goniolimon* spp. in perlite and peat, respectively, compared with seed germination in soil that support result of this study.

The highest values of seedlings root length (14cm) (Fig. 1b), shoot length (4.46cm) (Fig. 1c), and seedling fresh weight (5.3g) (Fig. 2b), were obtained with the mixture of 50% silt and 50% non-granular compost (NGC).

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However, root length was statistically not different from other combinations of Silt+NGC ($P<0.05$). The minimum values of these parameters were noted in control (Fig. 1 and Fig. 2). Increase in seedling length and fresh weight of seedling due to usage of compost has already been described by Bustamante et al. (2008), and Herrera et al. (2008) in different vegetable crops. Sarwar et al. (2018) also found increased seedling length and shoot weight of cucumber plants grown in growing media containing leaf silt, compost and perlite compared to those grown in silt.

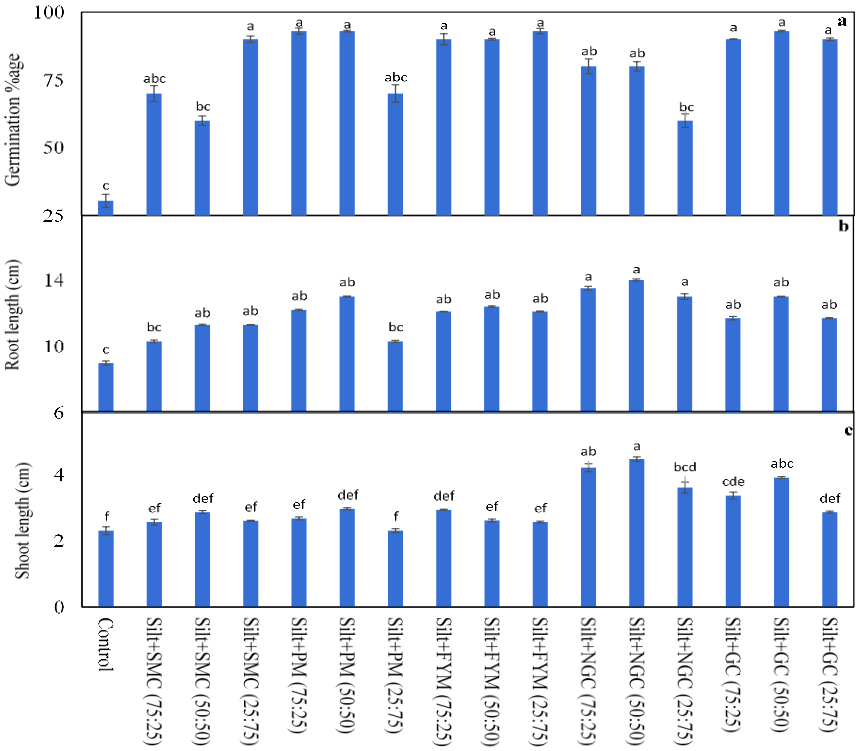

Fig. 1: Germination percentage (a), root length (b), and shoot length (c) of cucumber seedlings grown in various growing media. Vertical error bars represent standard error of means (n=4). SMC=Spent mushroom compost; PM=Press mud; FYM=farmyard manure; NGC=Non-granular compost; GC=Granular compost.

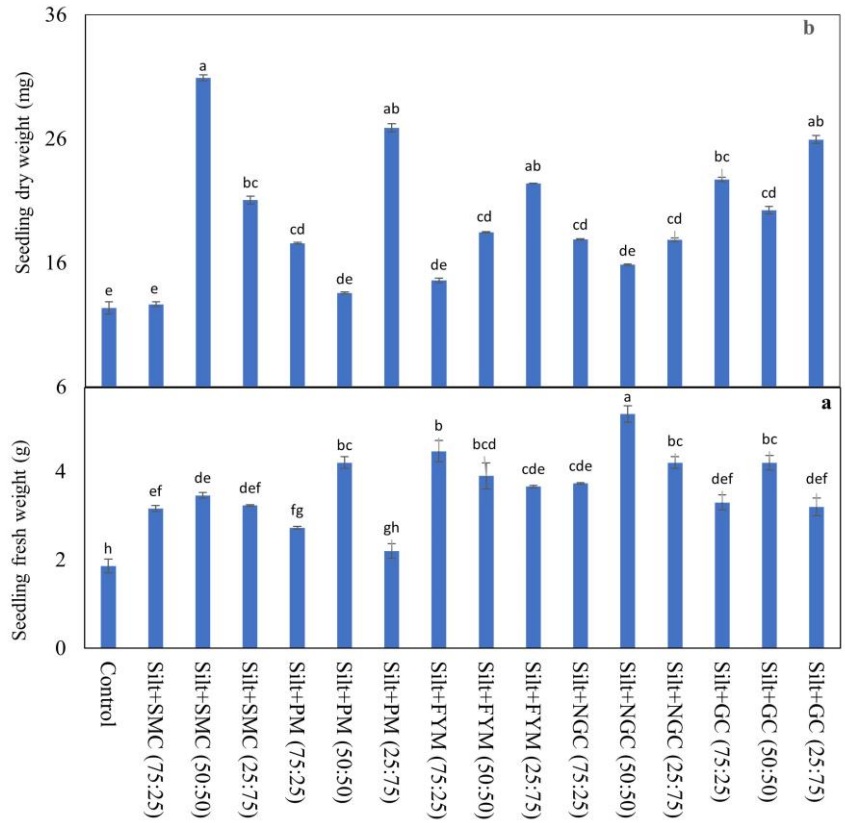

Fig. 2: Fresh weight (a) and dry weight (b) of cucumber seedlings grown in various growing substrates. (n=4). SMC=Spent mushroom compost; PM=Press mud; FYM=farmyard manure; NGC=Non-granular compost; GC=Granular compost.

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3.2. Yield parameters

The highest fruit yield, in terms of number (3.5) (Fig. 4a) and weight (1388.4 g) (Fig. 4b) of fruits plant^{-1} ($P<0.05$), was obtained for plants grown in media containing Silt:NGC in equal proportion (50% of each). Whereas, the control had the lowest yield (Figs. 4a and Fig. 4b). The fruit length (25.3cm) and fruit diameter (62.11cm) were also maximum in the mixture of 50% silt and 50% NGC (25.3cm) (Figs. 5a and 5b). Whereas the control had the lowest values for fruit length (20.5cm) and fruit diameter (43.0cm) (Fig. 13). These findings are in accordance to the report of Sarwar et al. (2018) who reported that cucumber plants in growing media containing leaf silt, compost and perlite in equal proportion compared to those grown in silt gave highest yield. Rashwan et al. (2021) reported that fruit size, weight and over all yield of cucumber and summer squash increased in media containing 15% tomato waste compost compared to control that partially support result of this study.

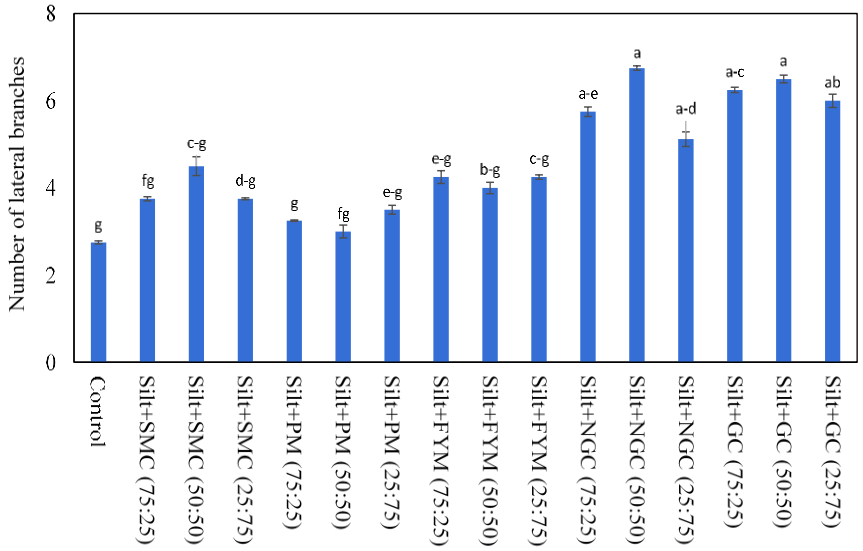

Fig. 3: Lateral branches of cucumber grown in various growing substrates. (n=4). SMC=Spent mushroom compost; PM=Press mud; FYM=farmyard manure; NGC=Non-granular compost; GC=Granular compost.

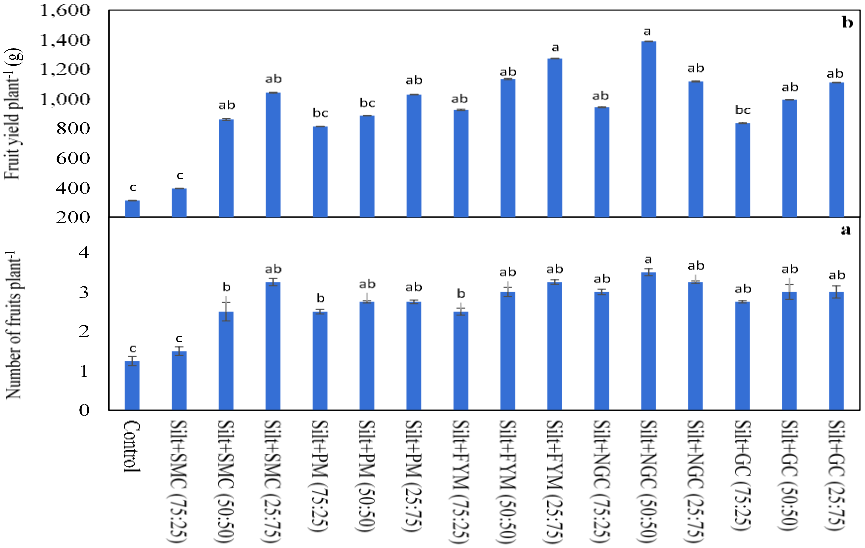

Fig. 4: Number of fruits (a) and fruit yield per plant (b) of cucumber grown in various growing substrates. (n=4). SMC=Spent mushroom compost; PM=Press mud; FYM=farmyard manure; NGC=Non-granular compost; GC=Granular compost.

3.3. Nutrient contents and biochemical parameters

The seedlings grown in mixture of 25% silt and 75% PM exhibited the highest P contents (0.40mg.g^{-1} dry weight) (Fig. 6a) and was statistically similar to that of silt and NGC (25%:75%) (Fig. 6a). While, the control seedlings had the lowest phosphorus contents (0.09mg.g^{-1} DW) (Fig. 6a). It is obvious that seedlings in mixture of 25% silt and 75% PM exhibited about 3.5 times more phosphorus compared to seedlings grown in silt. The seedlings grown in a mixture of 50% silt and 50% NGC had the highest N and K, i.e. 0.7 and 27.5mg.g^{-1} dry weight, respectively (Figs. 6b and 6c), i.e. twice the values of these nutrients in control (silt grown) cucumber plants, i.e. 0.34 and 12.2mg.g^{-1} dry weight, respectively (Figs. 6b and 6c). Sarwar et al. (2018) also found about double contents of nitrogen, phosphorus and potassium in leaves of cucumber seedlings grown in media containing

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coco-coir, silt, leaf compost and perlite. Lata et al. (2018) also reported higher NPK contents of cucumber fruit from plants grown in media containing vermicompost and garden soil with coco-coir top layer. Ahmad et al. (2020) also reported that nitrogen content of compost, prepared from different agricultural wastes combined in various ratios, was higher than silt and thus can improve nitrogen content of seedlings grown in it. Kamrani et al. (2019) observed highest nitrogen contents of potato plants in compost amended peat-based media compared to soil or peat used alone as growing media.

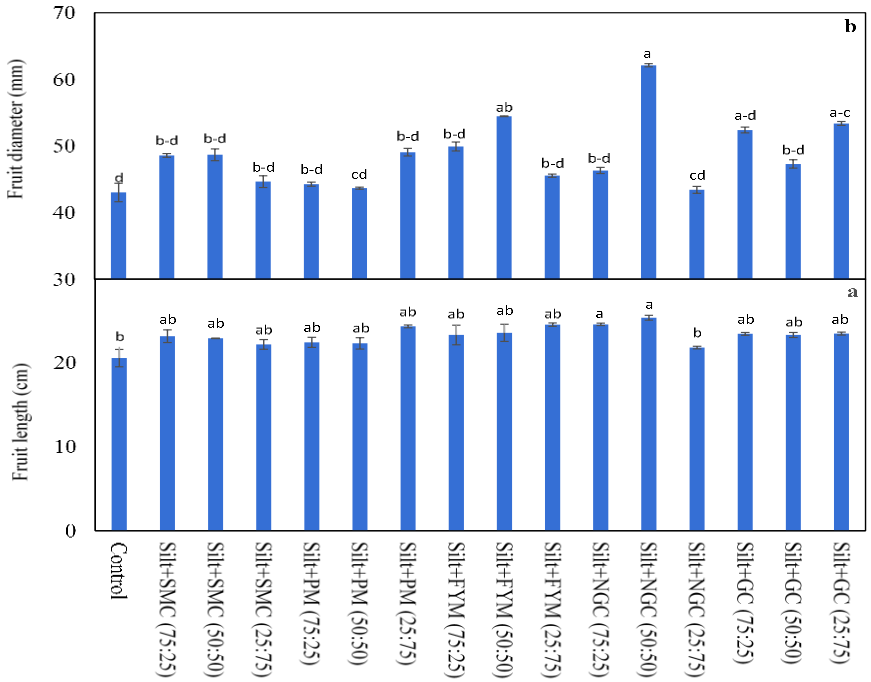

Fig. 5: Fruit length (a) and fruit diameter (b) of cucumber grown in various substrates. (n=4). SMC=Spent mushroom compost; PM=Press mud; FYM=farmyard manure; NGC=Non-granular compost; GC=Granular compost.

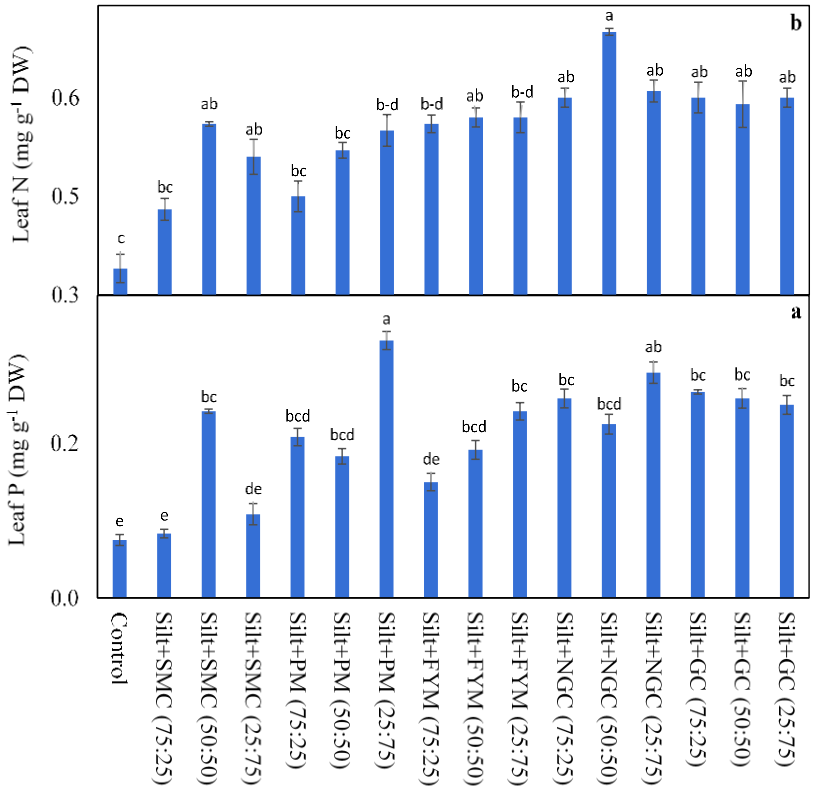

Fig. 6: Effect of different growing media on Leaf a) P, b) N, and c) K contents of cucumber. (n=4). SMC=Spent mushroom compost; PM=Press mud; FYM=farmyard manure; NGC=Non-granular compost; GC=Granular compost.

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Seedlings grown in mixture of 50% silt and 50% NGC also gave the maximum chlorophyll contents (105.9 SPAD units), 2.7 times higher than control (Fig. 7). However, chlorophyll contents (99.6 SPAD units) of seedlings raised in silt and spent mushroom compost (Silt 25%+ SMC 75%) were statistically at par with Silt+NGC (50%:50%) ($P<0.05$) (Fig. 7). The lowest chlorophyll contents (27.8 SPAD units) were noted in the mixture of silt and SMC (75%:25%) that was statistically similar to Silt+NGC (75%:25%) ($P<0.05$) (Fig. 7). Previously, Sarwar et al. (2018) recorded 64% higher chlorophyll contents in leaves of cucumber seedlings grown in media containing coco-coir, silt, leaf compost and perlite. These results are also in accordance to the findings of Lata et al. (2018) who observed higher chlorophyll contents in cucumber leaves in media containing vermicompost compared to garden soil and its combination with FYM.

The same mixture (50% silt + 50% NGC) also resulted in the highest soluble solid contents (SSC) (6.35ºBrix) (Fig. 8a) and total phenolic contents (55.5mg GAE $100g^{-1}$) (Fig. 8b) in cucumber fruit. Although, soluble solid contents of fruit in Silt+GC in 25%:75% ratio was statistically similar to Silt+NGC in 50%:50% ($P<0.05$). The minimum SSC (2.84ºBrix) (Fig. 8a) and phenolics (29.22mg GAE $100g^{-1}$) (Fig. 8b) were found in the control and Silt+Pressmud (75%:25%), respectively. These results are strengthened by the findings of Tzortzakis et al. (2020) who recorded higher soluble solids in tomato grown in soilless media compared to soil grown plants.

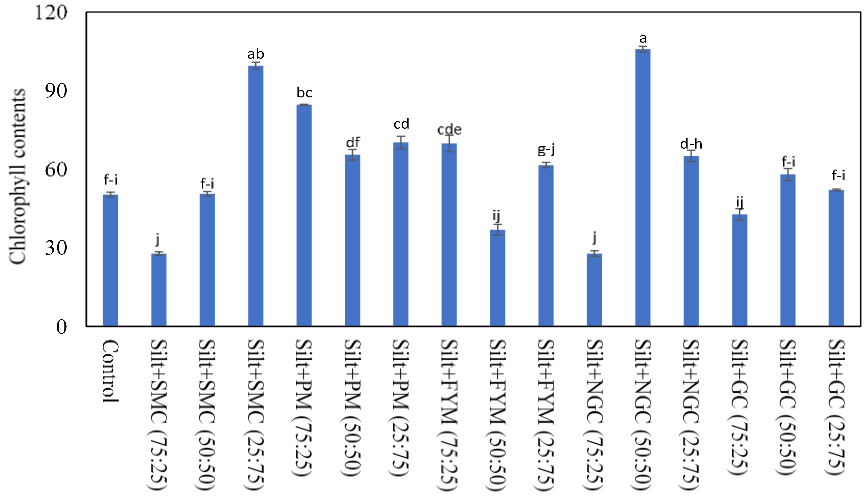

Fig. 7: Leaf chlorophyll contents (SPAD units) of cucumber seedlings grown in various growing substrates. (n=4). SMC=Spent mushroom compost; PM=Press mud; FYM=farmyard manure; NGC=Non-granular compost; GC=Granular compost.

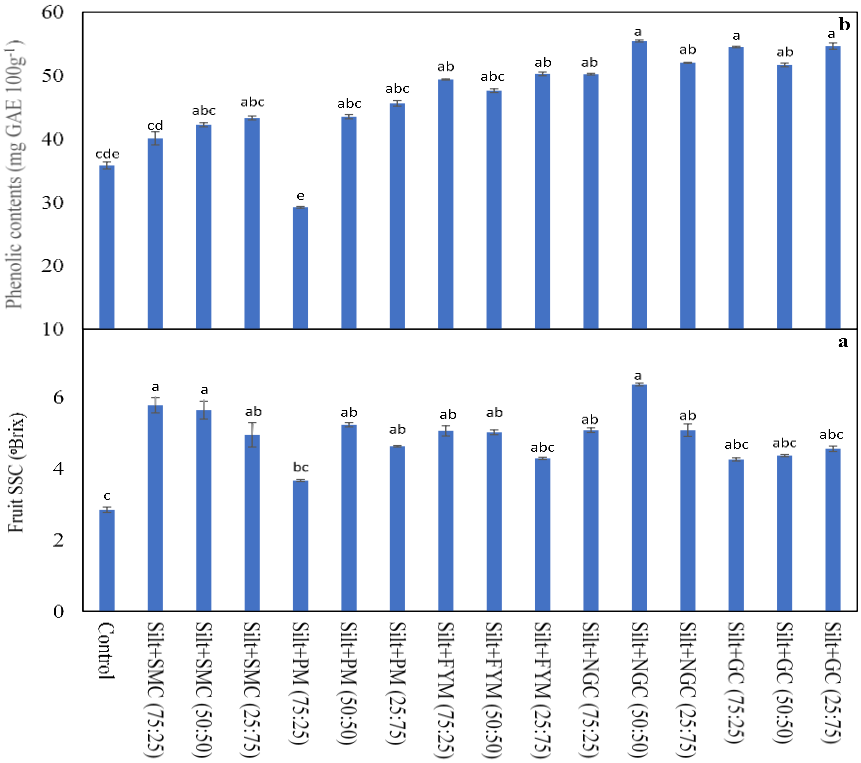

Fig. 8: Soluble solid contents (a) and total phenolic contents (b) of cucumber fruit grown in various growing substrates (n=4). SMC=Spent mushroom compost; PM=Press mud; FYM=farmyard manure; NGC=Non-granular compost; GC=Granular compost.

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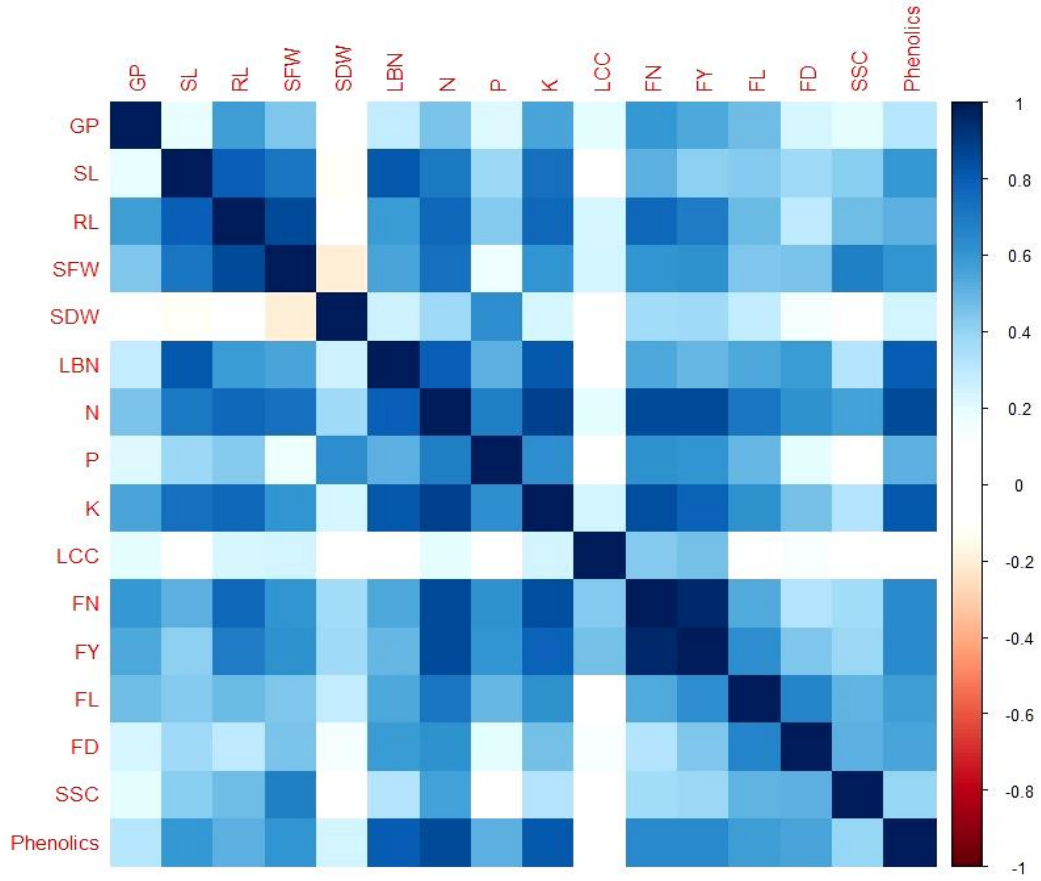

Fig. 9: Correlation between the different measured variables. GP=Germination percentage, SL=length of shoot, RL=length of root, SFW=fresh weight of seedling, SDW=dry weight of seedling, LBN=number of lateral branches, N=Leaf nitrogen, P=Leaf phosphorus, K=Leaf potassium, LCC=Leaf chlorophyll contents, FN=Fruits number plant^{-1}, FY=Fruits weight plant^{-1}, FL=Fruit length; FD=Fruit diameter, SSC=Soluble solid contents.

3.4. Correlation

Figure 9 represents a correlation between different measured variables of cucumber. Germination percentage (GP) had a moderate positive correlation with shoot fresh weight (SFW), root length (RL), leaf N and K, fruit yield plant^{-1} (FY), fruit number plant^{-1} (FN), and fruit length (FL). The shoot length (SL) showed a moderate positive correlation with FY, FN, FL, phenolics, and fruit soluble solid contents (SSC) and a strong positive correlation with leaf N and K, lateral branches number (LBN), and fruit diameter (FD). There was a moderate positive correlation of RL with GP, LBN, phenolics, and SSC, and a strong correlation with SL, SFW, leaf N and K, FY, and FN. The SFW had a moderate correlation with LBN, leaf K, FY, FN, FL, phenolics, while a strong correlation with SL and RL. The seedling dry weight (SDW) had a moderate positive correlation with leaf P. LBN showed a moderate correlation with RL, SFW, leaf P, FY, FN, FL, FD and a strong correlation with leaf N and K, and phenolics.

Figure 9 also reveals a moderate positive correlation of FN with GP, SL, SFW, LBN, leaf P, leaf chlorophyl content (LCC), phenolics, and FL while a strong positive correlation with RL, leaf N and K, and FY. Similarly, FY also had a moderate correlation with GP, SL, SFW, LBN, leaf P, LCC, FL, and phenolics, and a strong correlation with RL, leaf N and K, and FN. Whereas FL had a moderate correlation with all measured variables except SDW and LCC both had a weak correlation with FL. The FD had a moderate correlation with SFW, LBN, leaf N and K, FY, FL, SSC, and phenolics.

There was a moderate correlation of leaf N and K with GP, SFW, leaf P, FL, and FD and strong correlation with RL, SL, LBN, FY, FN, and phenolics. The leaf P had a moderate correlation with RL, LBN, leaf N and K, FY, FN, and FL. The LCC was found to have moderate correlation with FY and FN. The fruit SSC had a moderate correlation with RL, SL, SFW, leaf N, FL, and FD. The fruit phenolic contents had a moderate correlation with RL, SL, SFW, leaf P, FY, FN, FL, and FD and a strong correlation with LBN and leaf N and K.

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Conclusion: The study showed that the most suitable combination was that of silt and non-granular compost in a proportion of 50%:50% which enhanced growth, yield, and quality traits of cucumber. Moreover, it can be assumed from correlation analysis that media containing some proportion of silt will be suitable to get good yield if it permits high seed germination. Because ingredients of this media are cheap and locally available, so it can used for cucumber seedling production by nurserymen as well amateurs for growing cucumber as kitchen garden vegetable using organic substrates.

Contribution of Authors: KZ and IA conceived, designed and supervised this experiment. HH conducted experiment. MWH performed statistical analysis. KZ prepared the manuscript draft. MAG revised the draft. Anam Noor prepared graphs and cross-checked statistical analysis. All authors approved the final version of manuscript.

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