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Effect of different growing media and growing conditions on seed germination of guava and nutrients content of guava seedlings

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Abstract
The study was carried out to standardize the growing media for better germination of guava seeds (*Psidium guajava* L.) in cv. L-49 at CCS Haryana Agricultural University, Hisar during 2021-2022. The experiment had 10 treatments of various combinations of growing media *viz.* Garden soil, Garden soil + FYM (1:1), Garden soil + Vermicompost (1:1), Garden soil + Cocopeat (1:1), Garden soil + Vermiculite (1:1), Garden soil + Sawdust (1:1), Garden soil + FYM + Vermicompost (2:1:1), Garden soil + FYM + Cocopeat (2:1:1), Garden soil + FYM + Vermiculite (2:1:1), Garden soil + FYM + Sawdust (2:1:1) under two environmental conditions (open field and polyhouse). Among different treatment combinations, treatment of garden soil + FYM + vermicompost (2:1:1) had taken minimum number of days for full germination (23.95 & 21.67) and 50% germination (27.93 & 24.54) and the highest germination percentage (43.25 & 46.27) in polyhouse and field condition, respectively and had the highest N, P and K content in guava seedling leaves under both growing conditions. This treatment was significantly at par with the Garden soil + FYM + Cocopeat (2:1:1) in term of all the parameters studies. Among the two growing conditions, the number of days taken for full and 50% germination, N, P and K content in guava seedling leaves and in growing media were better, in poly house compared to open field conditions. There was strong correlation between seed germination percentage of guava and N, P and K content in guava seedling leaves.

Keywords: Guava, growing media, FYM, vermicompost, coco peat, garden soil

Introduction

The wide adaptability nature of the guava tree helped it to sustain a wide range of environmental conditions, soils, pH (4.5 to 8.2), drought and salinity. It is susceptible to frost. It is quite a hardy, prolific bearer and considered to be one of the most delicate nutritionally valuable and remunerative crops of the tropics (Sharma *et al*., 2020; Singh *et al*., 2000) [10, 12]. Since in Haryana guava is a remunerative crop, the area under guava cultivation is increasing day by day. The farmers also adopt new techniques such as high-density planting and meadow orcharding for better production and productivity. Because of this, there is an increase in demand for budded and grafted plants, but this demand is not fulfilled because of the deficiency of superior seedling rootstock due to poor seed germination and seedling growth. These factors adversely affect the production and productivity levels in guava cultivation. The supply of quality planting material is essential for good tree survival and better establishment in the field (Bally, 2006) [2].

The modern exercise of raising seedlings in a nursery is the use of polythene bags with potting media consisting of FYM, soil and sand combined in the ratio of 1:2:1 respectively. The physical and chemical properties of media like structure, texture, pH, nitrogen, phosphorus, and potassium are important factors for the growth and development of plants.

The growing media should be porous, uniform in texture, hold sufficient moisture, and be well-drained. The composition and nutritional status of the medium is considered to be helpful for the production of good quality plants. Important media used to raise nursery plants are soil, FYM, vermicompost, cocopeat, vermiculite, sphagnum moss etc. Therefore, keeping all these points in view, the present study was undertaken to study the effect of different growing media on seed germination of guava.

Materials and Methods

Experimental Details

The experiment was carried out under both poly house and in open field conditions at nursery and Precision Farming Development Centre, Department of Horticulture, CCS Haryana Agricultural University, Hisar, in the year 2021-2022.The experiment was laid out in randomized block design with three replications. The treatments comprising 10 media combinations under each condition. The following treatments were under both growing conditions: T_1: Garden soil, T_2: Garden soil + FYM (1:1), T_3: Garden soil + Vermicompost (1:1), T_4: Garden soil + Cocopeat (1:1), T_5: Garden soil + Vermiculite (1:1), T_6: Garden soil + Sawdust (1:1), T_7: Garden soil + FYM + Vermicompost (2:1:1), T_8: Garden soil + FYM + Cocopeat (2:1:1), T_9: Garden soil + FYM + Vermiculite (2:1:1), T_{10}: Garden soil + FYM + Sawdust (2:1:1).

Fully matured fruits of guava *cv.* L-49 were collected from Experimental Orchard of the Department of Horticulture, washed and cleaned thoroughly. Then, the fruits were mashed and mixed with water to extract the seeds by removing the pulpy material. The extracted seeds were dried under shade for one day and were ready for sowing. In each polybag, two seeds were sown during the 2nd week of September 2021. Polybags were irrigated after seed sowing and after that, moisture was maintained regularly. Weeding was done manually at regular interval.

Days taken for germination were recorded from the date of sowing to the plumule comes out above the soil surface. The average time required for germination in each replication was calculated. Number of days required to reach 50% of the germination was computed from the germination percentage calculated for each observation during the course of experiments. The germination percentage was calculated by the number of germinated seeds divided by the total number of seeds sown and multiplied by 100.

Soil and Plant Analysis

The samples of different growing media were analysed for N, P and K contents before the start of experiment (sowing of seeds) and after the completion of experiment. Nutrient contents of leaves of seedlings for each treatment were also analysed in the end of experiment (after four months). Nutrients (N, P, K) analysis of growing media and guava seedling leaves were done as per standard methods.

Statistical Analyses

Final data were analysed using online statistical analysis package OPSTAT (Sheoran, 2010) [11] and treatments means were compared by C.D. at 5% level of significance. The data for N, P, K content in leaves of Guava seedlings and days taken of germination of by each treatment were correlated and were shown in figures.

Results and Discussion

Effect of different growing media on germination of guava seed

Days taken for germination

It is evident from Table 1 that all growing media significantly reduced the days to initiation of germination of guava seeds and 50% germination as compared to garden soil only in both the growing conditions i.e., open field and polyhouse. Among different treatments, significantly lower average number of days (23.95 & 21.67) for seed germination and 50% germination (27.93 & 24.54) were observed in the treatment in the treatment of Garden soil + FYM + vermicompost (2:1:1). The treatment of garden soil + FYM + vermicompost (2:1:1) was significantly at par with the Garden soil + FYM + Cocopeat (2:1:1) in term of days taken for seed germination and 50% germination. The better effect of garden soil + FYM + vermicompost on seed germination could be due to its appropriate cation exchange capacity for nutrient retention, good water holding capacity and sufficient porous properties. These properties allow adequate moisture and gas exchange between the germination growth media and the embryo, which is necessary for rapid and uniform seed germination in mango and in ber (Parasana *et al*. 2013 and Singh *et al.* 2023) [6, 13]. This result is akin to the findings of Abirami *et al*. (2010) [1].

Among the two growing conditions, the average 25.43 minimum days were taken for germination and 30.49 days for 50% germination of seeds in polyhouse and 28.52 and 35.82 numbers of days were taken in open field condition. This may be due to high relative humidity and ensured water availability water under polyhouse condition (Mithapara *et al.* 2021) [5]. Similar result was found by Parmar *et al*. (2015) [7].

Table 1: Effect of different growing media on germination of guava seed

	Treatments	Av. Days taken for initial Germination		Days to 50% Germination	
		Field	Polyhouse	Field	Polyhouse
T_1	GS	34.97	30.80	44.53	39.07
T_2	GS + FYM	27.60	24.70	35.17	30.17
T_3	GS + VC	26.33	23.67	33.9	27.50
T_4	GS + CoP	28.93	25.50	36.83	32.17
T_5	GS + Verm	31.83	28.50	38.50	33.17
T_6	GS + SawD	33.17	28.83	43.87	37.00
T_7	GS + FYM + VC	23.95	21.67	27.93	24.54
T_8	GS + FYM + CoP	25.07	22.93	29.78	26.13
T_9	GS + FYM + Verm	25.83	23.27	33.33	26.67
T_{10}	GS + CoP + SawD	27.50	24.43	34.33	28.50
	Mean	28.52	25.43	35.82	30.49
	C.D. (at 5%)	2.21	1.46	2.11	1.76

T_1: Garden soil, T_2: Garden soil + FYM (1:1), T_3: Garden soil + Vermicompost (1:1), T_4: Garden soil + Cocopeat (1:1), T_5: Garden soil + Vermiculite (1:1), T_6: Garden soil + Sawdust (1:1), T_7: Garden soil + FYM + Vermicompost (2:1:1), T_8: Garden soil + FYM + Cocopeat (2:1:1), T_9: Garden soil + FYM + Vermiculite (2:1:1), T_{10}: Garden soil + FYM + Sawdust (2:1:1)

Germination percentage

Data revealed that germination percentage was influenced by growing conditions i.e., open field and polyhouse (Table 2). Under field condition germination percentage in various treatment varied from 26.90 to 43.25%, whereas, in polyhouse condition, germination percentage in various treatment varied from 30.52 to 46.27% with an average of 40.37% over the treatments. Among different treatments, significantly higher germination percent (43.25 & 46.27) in open field and poly house and were observed in the treatment of garden soil + FYM + vermicompost (2:1:1). The treatment of garden soil + FYM + vermicompost (2:1:1) was significantly at par with the Garden soil + FYM + Cocopeat (2:1:1) in term of germination percentage. It could be because organic manure-containing media contain organic acid. As a result, there is more moisture accessible and certain acids may have contributed towards germination of seeds. The lowest germination (28.71%) was recorded in treatment of garden soil (control). Vermicompost modifies soil structure, improves the availability of nutrients, and increases the media's ability to retain water, in addition to enhancing microbial and enzymatic activities that have long-lasting residual impacts in Khirni (Samir *et al*. 2016) [8]. Vermicompost has bioactive principles considered to be beneficial for germination and growth of the plant, as also having a balanced composition of nutrients in mango (Kaur 2017) [4].

Among two growing conditions, significantly higher germination percentage (40.37%) was recorded in polyhouse conditions. In open field condition 36.68% of germination was recorded irrespective of growing medium. This could be because a greenhouse permits air to press closer to the foliage for peak photosynthesis and carbon dioxide concentration. Similar results were also reported by Sharma *et al.* (2020) [10] in guava. Also due to higher relative humidity in polyhouse as compared to open field conditions. Similar result was found by Syamal *et al.* (2013) [15] in bael and Syamal, *et al*. (2012) [14] in guava.

Table 2: Effect of different growing media on guava seed germination percentage

	Treatments	Germination Percentage	
		In Field	In Polyhouse
T_1	GS	26.90	30.52
T_2	GS + FYM	37.11	41.22
T_3	GS + VC	38.50	43.25
T_4	GS + CoP	36.40	40.69
T_5	GS + Verm	32.95	36.63
T_6	GS + SawD	32.52	34.51
T_7	GS + FYM + VC	43.25	46.27
T_8	GS + FYM + CoP	41.11	44.13
T_9	GS + FYM + Verm	40.43	43.45
T_{10}	GS + CoP + SawD	37.63	43.05
	Mean	36.68	40.37
	C.D. (at 5%)	2.23 2.37	

T_1: Garden soil, T_2: Garden soil + FYM (1:1), T_3: Garden soil + Vermicompost (1:1), T_4: Garden soil + Cocopeat (1:1), T_5: Garden soil + Vermiculite (1:1), T_6: Garden soil + Sawdust (1:1), T_7: Garden soil + FYM + Vermicompost (2:1:1), T_8: Garden soil + FYM + Cocopeat (2:1:1), T_9: Garden soil + FYM + Vermiculite (2:1:1), T_{10}: Garden soil + FYM + Sawdust (2:1:1)

Nutrient Analysis of Growing Media
Before Sowing

The data on available nutrient contents in the growing media before sowing of seed (Table 3) indicates that the highest nitrogen level (173.2kg/ha), phosphorous (39.1 kg/ha) and potassium (269.3 kg/ha) were found in treatment of garden soil + FYM + vermicompost (2:1:1) followed by garden soil + FYM + cocopeat (2:1:1) i.e., 160.5 kg/ha (N), 39.1kg/ha (P) and 259.70 kg/ha. The lowest values of these nutrients were recorded in garden soil (control).

Table 3: Available N, P and K of different growing media (kg/ha) before sowing

	Treatments	Nitrogen	Phosphorous	Potassium
T_1	GS	119.2	13.2	228.8
T_2	GS + FYM	134.6	26.5	240.1
T_3	GS + VC	150.5	30.2	250.5
T_4	GS + CoP	126.8	24.7	237.4
T_5	GS + Verm	123.7	17.6	234.6
T_6	GS + SawD	120.8	16.3	230.2
T_7	GS + FYM + VC	173.2	45.7	269.3
T_8	GS + FYM + CoP	160.5	39.1	259.7
T_9	GS + FYM + Verm	157.4	35.2	255.4
T_{10}	GS + CoP + SawD	138.5	28.2	244.6
	C.D. (at 5%)	6.49	3.13	4.51

T_1: Garden soil, T_2: Garden soil + FYM (1:1), T_3: Garden soil + Vermicompost (1:1), T_4: Garden soil + Cocopeat (1:1), T_5: Garden soil + Vermiculite (1:1), T_6: Garden soil + Sawdust (1:1), T_7: Garden soil + FYM + Vermicompost (2:1:1), T_8: Garden soil + FYM + Cocopeat (2:1:1), T_9: Garden soil + FYM + Vermiculite (2:1:1), T_{10}: Garden soil + FYM + Sawdust (2:1:1)

Nutrient Analysis of Growing Media
After experiment

The available nutrient status N, P and K content in different treatments of growing media in both the growing conditions i.e polyhouse and in open field condition is presented in presented in Table 4. If we compare the N, P and K content in different treatment before sowing of seed and after experiment, there was decrease in the N, P and contents. This showed that continuously uptake of N, P and K from media in each treatment has supplied nutrients for seeding germination and growth and thereby depletion in the nutrient content in the media. The garden soil + FYM + vermicompost (2:1:1) treatment even after these days still had the maximum N, P and K content. Among the different treatment in open field condition the maximum nitrogen content (145.50 kg/ha), phosphorous (28.5 kg/ha) and potassium (245.1 kg/ha) were found in garden soil + FYM + vermicompost (2:1:1). Similarly in poly house condition, the maximum nitrogen content (143.20 kg/ha), phosphorous (25.7 kg/ha) and potassium (243.7 kg/ha) were observed. Whereas among the different treatment in polyhouse condition, the lowest nitrogen content (110.7 kg/ha), phosphorous (7.25 kg/ha) and potassium (220.4 kg/ha) were found in garden soil + FYM + vermicompost (2:1:1). Similarly in open field condition the maximum nitrogen content (112.5 kg/ha), phosphorous (9.2 kg/ha) and potassium (221.7 kg/ha) were observed. This showed that the among the different treatment the treatment of garden soil + FYM + vermicompost (2:1:1) continuously maintain the higher availability of N, P, and K content for the germination and growth of seedlings. The highest available N, P and K status in the treatment of garden soil + FYM + vermicompost (2:1:1) was due to the combined effect of vermicompost, FYM in garden soil (Chiranjeevi *et al*. 2018) [3].

Table 4: Available N, P and K of different growing media (kg/ha) - After experiment

	Treatments	Nitrogen		Phosphorous		Potassium	
		In Field	In Polyhouse	In Field	In Polyhouse	In Field	In Polyhouse
T_1	GS	112.5	110.7	9.2	7.25	221.7	220.4
T_2	GS + FYM	123.2	121.85	16.7	13.64	230.5	228.6
T_3	GS + VC	128.4	125.1	20.7	17.32	236.8	234.9
T_4	GS + CoP	120.4	119.1	13.2	10.15	228.7	227.6
T_5	GS + Verm	118.6	116.9	11.4	9.53	227.1	226.3
T_6	GS + SawD	117.3	115.8	10.2	8.78	225.6	224.1
T_7	GS + FYM + VC	145.5	143.2	28.5	25.72	245.1	243.7
T_8	GS + FYM + CoP	138.4	136.8	24.2	21.65	240.4	238.8
T_9	GS + FYM + Verm	133.60	131.7	22.4	18.3	238.6	236.2
T_{10}	GS + CoP + SawD	125.20	122.8	19.10	16.8	233.7	232.5
	Mean	126.31	124.4	17.56	14.91	232.82	231.31
	C.D. (at 5%)	3.95 3.84		3.48 1.71		3.07 2.16	

T_1: Garden soil, T_2: Garden soil + FYM (1:1), T_3: Garden soil + Vermicompost (1:1), T_4: Garden soil + Cocopeat (1:1), T_5: Garden soil + Vermiculite (1:1), T_6: Garden soil + Sawdust (1:1), T_7: Garden soil + FYM + Vermicompost (2:1:1), T_8: Garden soil + FYM + Cocopeat (2:1:1), T_9: Garden soil + FYM + Vermiculite (2:1:1), T_{10}: Garden soil + FYM + Sawdust (2:1:1)

N, P and K content in seedlings leaves

The data on N, P and K content in seedling leaves are presented in Table 5, which showed that nitrogen, phosphorus and potassium content in guava seedling leaves were different in different treatment of the growing media, in both field and poly house condition. Among the different treatment in open field condition the maximum nitrogen (1.35%), phosphorous (0.17%) and potassium (0.43%) of leaves were found in garden soil + FYM + vermicompost (2:1:1). Similarly in poly house condition, the maximum nitrogen (1.52%), phosphorous (0.17%) and potassium (0.45%) of leaves were found in garden soil + FYM + vermicompost (2:1:1). The findings are also in agreement with those of Sarita *et al.* (2019) [9] in litchi.

Table 5: Effect of different growing media on N, P and K content (%) of guava leaves

Treatments (T)	Nitrogen		Phosphorous		Potassium	
	In Field	In Polyhouse	In Field	In Polyhouse	In Field	In Polyhouse
GS	0.95	1.09	0.13	0.13	0.37	0.38
GS + FYM	1.10	1.22	0.14	0.14	0.38	0.39
GS + VC	1.16	1.31	0.14	0.16	0.4	0.41
GS + CoP	1.03	1.19	0.14	0.14	0.38	0.39
GS + Verm	1.01	1.15	0.13	0.13	0.37	0.38
GS + SawD	0.98	1.11	0.13	0.13	0.37	0.38
GS + FYM + VC	1.35	1.52	0.17	0.17	0.43	0.45
GS + FYM + CoP	1.31	1.42	0.16	0.16	0.42	0.43
GS + FYM + Verm	1.22	1.35	0.16	0.16	0.41	0.42
GS + CoP + SawD	1.11	1.25	0.15	0.15	0.39	0.40
Mean	1.12	1.26	0.14	0.15	0.39	0.40
C.D. (at 5%)	0.02 0.02		NSNS		0.01 NS	

T_1: Garden soil, T_2: Garden soil + FYM (1:1), T_3: Garden soil + Vermicompost (1:1), T_4: Garden soil + Cocopeat (1:1), T_5: Garden soil + Vermiculite (1:1), T_6: Garden soil + Sawdust (1:1), T_7: Garden soil + FYM + Vermicompost (2:1:1), T_8: Garden soil + FYM + Cocopeat (2:1:1), T_9: Garden soil + FYM + Vermiculite (2:1:1), T_{10}: Garden soil + FYM + Sawdust (2:1:1)

Relationship of N, P and K content and germination percentage of guava seedlings

The different combination of growing media affected the N content in the leaves of guava seedling. Further N content in the seedling leaves can be related to the germination % of guava seed. There is strong correlation between N content of seedling leaves and germination percentage of guava in both the growing condition i.e. field (r= 0.84) and seed grown in the polyhouse (r=0.77) (Fig 1, 4).

Similarly the different combination of growing media affected the P content in the leaves of guava seedlings. Further P content in the seedling leaves can be related to the germination % of guava seed. There is strong correlation between P content of seedling leaves and germination percentage of guava seed in both the growing condition i.e. field (r= 0.78) and seed grown in the polyhouse (r=0.79) (Fig 2, 5).

Similar trend was also observed in case of K content of Guava seedling leaves and germination % in different growing media. There is good correlation between K content of seedling leaves and germination percentage of guava in both the growing condition i.e. field (r= 0.78) and seed grown in the polyhouse (r=67) (Fig 3, 6).

These correlations clearly indicates that with increase in N, P and K content of guava seedling leaves the germination % of 0 guava seeds increased. This is due to better availability of N, P and K at the time of embryo development and germination growth media, which enhances the germination % thereby growth of seedlings.

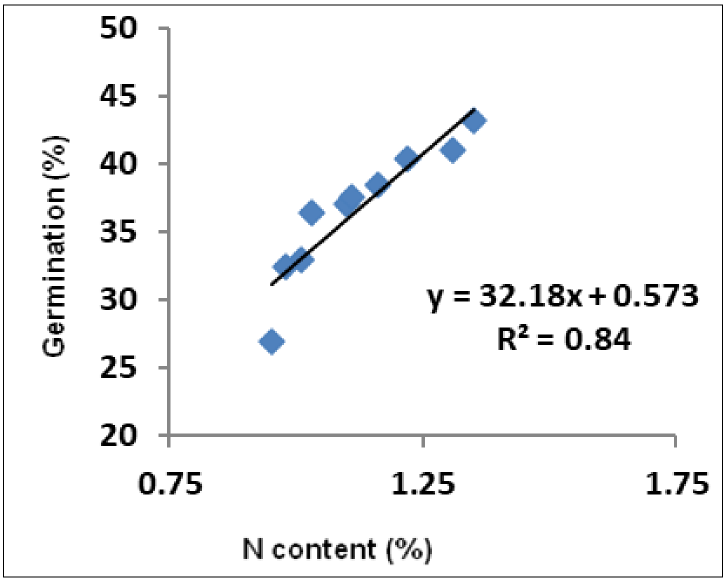

Fig 1: Relationship of N content (%) and Germination (%) percentage of guava seedlings grown in field

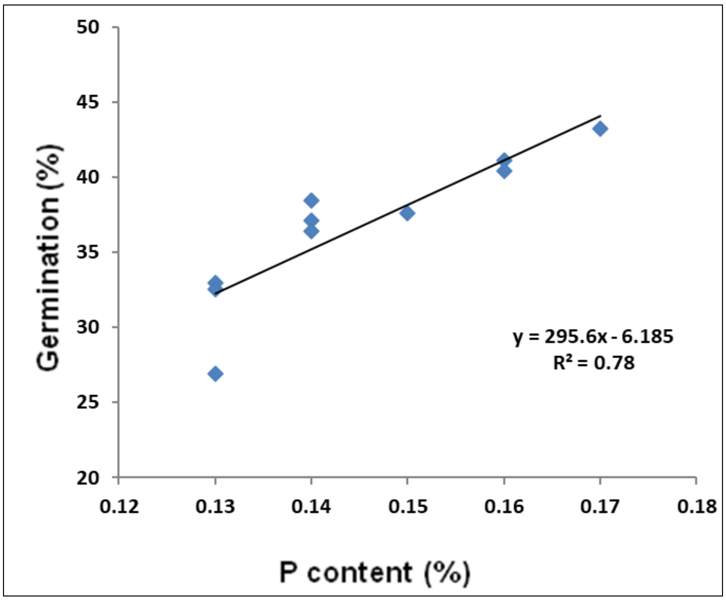

Fig 2: Relationship of P content (%) and Germination (%) percentage of guava seedlings grown in field

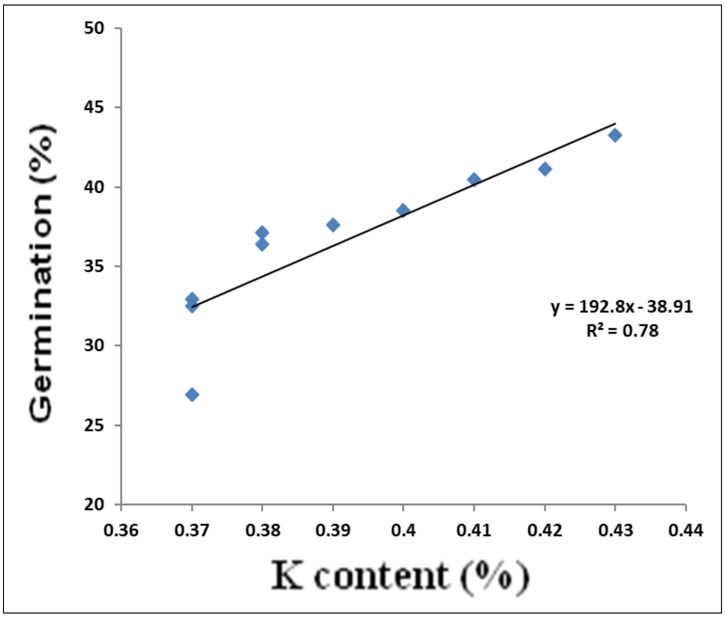

Fig 3: Relationship of K content (%) and Germination (%) percentage of guava seedlings grown in field

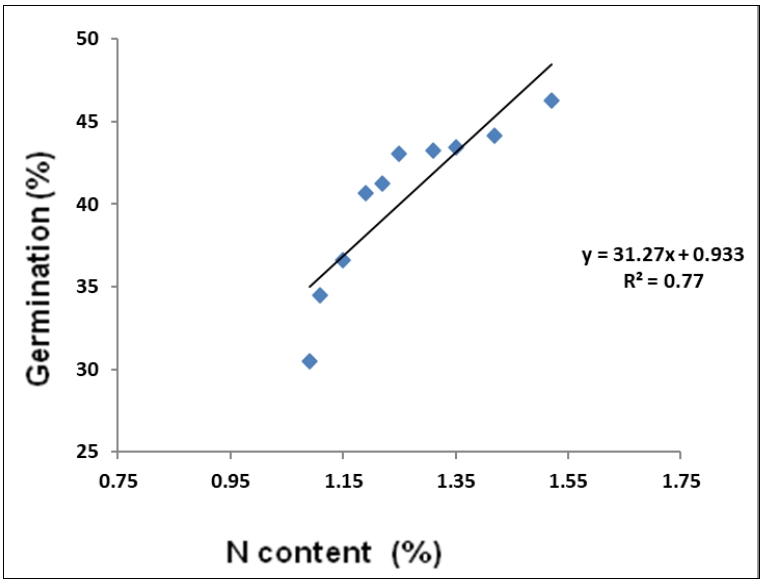

Fig 4: Relationship of N content (%) and Germination (%) percentage of guava seedlings grown in Polyhouse

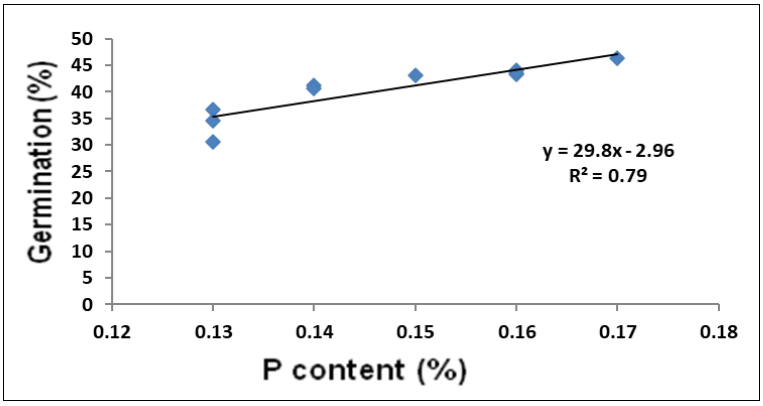

Fig 5: Relationship of P content and Germination (%) percentage of guava seedlings grown in Polyhouse

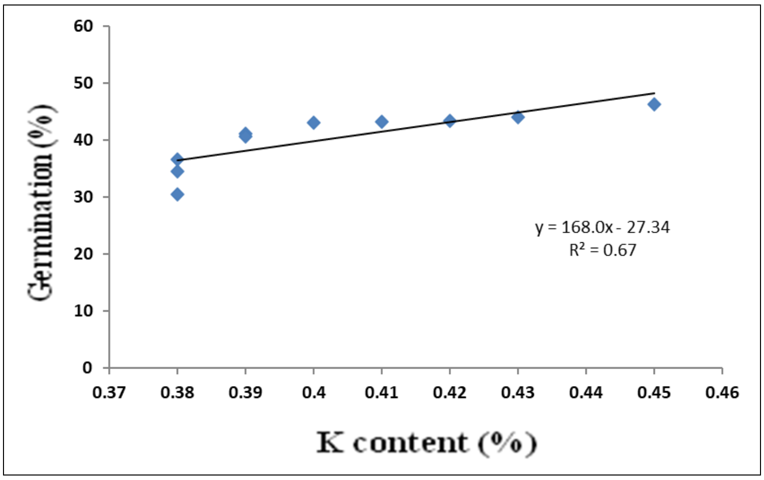

Fig 6: Relationship of K content (%) and Germination (%) percentage of guava seedlings grown in Polyhouse

Conclusion

It could be concluded that among the different treatment on growing media, seeds sown in media combination of garden soil + FYM + vermicompost (2:1:1) showed the highest seed germination, days to 50% germination and germination percentage and availability of N, P and K content in guava seedling leaves. The treatment of garden soil + FYM + vermicompost (2:1:1) was similar to the Garden soil + FYM + Cocopeat (2:1:1) in term of all the parameters studies. Further, two growing conditions poly house conditions were found best for all germination parameters and nutrient contents of guava seedling leaves compared to open field condition. Therefore for the combination of Garden soil + FYM + vermicompost or cocopeat in polyhouse condition, can be used for growing of Guava seedlings for higher percentage and numbers of days taken to germinate. These conditions provide the better nutrient utilization, aerations and water availability.

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