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Effect of Manure and Bio-fertilizers on Seed yield and Seedling characteristics of Carrot Seed Crop Grown in Northern Plains of India

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ABSTRACT: Healthy seed and seedling of crop are the basic requirements for any successful crop production. Less germination percentage in carrot crop (60%) is undesirable; also the large amount of chemicals being sprayed in vegetable root crops is dangerous for consumers health. This study was carried out at Seed Research Farm of Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during the spring-summer season of 2019-20. Objectives of this experiment were to analyse the effect of manures and biofertilziers on seed yield and seedling growth characteristics in carrot crop. The experiment consisted of fourteen treatments, *viz.*, T1- Absolute control, T2- RDF (N:P:K 80:40:40 kg/ha), T3- Farmyard manure 25t/ha, T4- Poultry manure 4t/ha, T5- Vermicompost 8t/ha, T6- FYM 12.5t/ha + PM 2t/ha, T7- FYM 12.5t/ha + PM 2t/ha, T8- FYM 12.5t/ha + PM 2t/ha + VC 4t/ha, T9- FYM 12.5t/ha + PM 2t/ha + *Azo* + *PSB*, T10-FYM 12.5t/ha + *Azo* + *PSB*, T11- FYM 12.5t/ha + VC 4t/ha + *Azo* + *PSB*, T12- VC 8t/ha + *Azo* + *PSB*, T13- PM 4t/ha + *Azo* + *PSB* and T14- FYM 12.5t/ha + PM 2t/ha + VC 4t/ha + *Azo* + *PSB* and was laid out in Randomized Block Design with three replications. Seed yield parameters, such as number of branches per plant, days to 50% flowering, number of seeds per umblets, seed yield, and seedling characteristics, such as germination percentage, vigour index I, vigour index-II and electrical conductivity, of carrot cv. Hisar Gairic was found highest with treatment T14 (FYM 12.5t/ha + PM 2t/ha + VC 4t/ha + *Azo* + *PSB)*, which was at par with treatments T8, T9, T11 and T2.

Keywords: Biofertilizers, carrot, manures, seed, vigour.

INTRODUCTION

Carrot (*Daucus carota* var. *atrorubens*) belonging to family *Umbelliferae* with chromosome number 2n=18 is a popular cool-season vegetable root crop. It is grown throughout the world, in temperate countries mainly during the spring-summer season, while in tropical regions, during the winter season. The area under carrot crop in India is reported to be 1.09 lakh ha with an annual production of 18.93 lakh metric tonnes (Anonymous, 2). Uttar Pradesh, Assam, Karnataka, Andhra Pradesh, Punjab and Haryana are the important growing states in India. In one season, it produces high-quality edible root and in two seasons, produces seeds. Its cultivated forms have been domesticated from wild species. Carrot is cultivated in some countries for its seed, which is the source of essential carrot seed oil. Carrot is grown from true seeds and its successful production is dependent upon a sustainable and satisfactory supply of good quality seed.

One of the major problems faced by carrot growers in India is the unavailability of the required amount of good quality seed. However, the seed supply from the domestic production is not adequate and growers depend mainly on imported seeds that demand foreign currency and are of questionable sources concerning germination and susceptibility to diseases (Mengistu and Yamoah 2010). Thus, to improve the production and productivity of carrots domestically, the availability of quality seed is crucial.

Organic seed is the planting material produced by a crop that is planted and raised organically for a minimum of one generation in the case of annual crops, and two generations in the case of biennial and perennial crops (Lammerts, 2002). Organic seed production includes the growing of seed crops by a collection of guidelines that prohibit the use of synthetic products/chemicals. Studies conducted by Nascimento *et al.* (2008) indicated that it is possible to obtain organic carrot seeds with good physiological and pathological quality. Root length increase in carrots with the successive increase in different organic fertilizers (Mbatha, 2008). Haider *et al.* (2012) reported the positive effect of cowdung 10 t/ha on carrot seed production. Haleshkumar (2009) observed significantly superior seed quality parameters like germination

(76.33%), seedling dry weight (137.56 mg) in carrot crops by using sheep manure and FYM. To further contribute to these research findings, this study was carried out to analyse the effect of manure and biofertilizers on seed yield and seedling characteristics of the carrot seed crop.

MATERIALS AND METHODS

The present study was conducted at Seed Research Farm of Department of Vegetable Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar (29°09′N and 75°43′E, elevation 215 m) during the spring-summer season of 2018-19. The experiment included fourteen treatments, *viz*., T1- Absolute control, T2- RDF (N:P:K 80:40:40 kg/ha), T3- Farmyard manure 25t/ha, T4- Poultry manure 4t/ha, T5- Vermicompost 8t/ha,T7- FYM 12.5t/ha + PM 2t/ha, T8- FYM 12.5t/ha + PM 2t/ha + VC 4t/ha, T9- FYM 12.5t/ha + PM 2t/ha + *Azo* + *PSB*, T10-FYM 12.5t/ha + *Azo* + *PSB*, T11- FYM 12.5t/ha + VC 4t/ha + *Azo* + *PSB*, T12- VC 8t/ha + *Azo* + *PSB*, T13- PM 4t/ha + *Azo* + *PSB* and T14- FYM 12.5t/ha + PM 2t/ha + VC 4t/ha + *Azo* + *PSB* and was laid out in Randomized Block Design with three replications. The crop was sown on 8th October 2019. All recommended packages of practices were followed uniformly as per the crop requirements with irrigation and required data was recorded. The seeds were harvested manually on 1st June 2020 and seed yield was estimated. Later on, these seeds were stored for further analysis of characteristics of seedling of carrot seeds so harvested. The parameters recorded for the assessment of seed quality during storage of six months were Germination (%), Vigour index-I (based on seedling length), Vigour index-II (based on seedling dry weight), Electrical Conductivity (dS/m). Statistical analysis of experimental data was conducted using the OPSTAT software package.

RESULTS AND DISCUSSION

Number of branches: Data presented in Table 1 shows the significant influence of different treatments of manure and biofertilizers on the number of branches per plant of carrot seed crop at 30, 60 and 90 days after steckling planting and at final harvest. Maximum number of branches were recorded at 30, 60, 90 DAP and at final harvest, when the carrot seed crop was treated with T14 (FYM 12.5t/ha + PM 2t/ha + VC 4t/ha + Azo + PSB), while the minimum number of branches was observed under control. This significant increase in the number of branches and other growth attributes may be attributed to the action of applied manures, which contained all the macronutrients and most of the micronutrients which are needed for the crop growth, and biofertilizers, which led to an increase in the availability of N resulting in the production of ammonia, vitamins and plant growth substances. Similar findings were reported by Kanaujia (2013); Pal *et al*. (2019); Roshni *et al*. (2019) in carrot.

Days to 50% flowering: The data on 50% flowering depicted in Table 1 shows that the various treatments did not significantly influence the days to 50% flowering. However, among all the treatment combinations, maximum days to 50% flowering was observed with the control treatment and minimum days to 50 % flowering was observed in T14 which consisted of FYM 12.5t/ha + PM 2t/ha + VC 4t/ha + Azo + PSB. This might be due to the inability of the plant to transport the additional food material as a result of which plants showed reproductive response synchronously regardless of the treatments given to them.

Table 1: Effect of manures and biofertilizers on days to 50% flowering, number of branches, number of seeds/umblets and seed yield (q/ha) of carrot seed crop.

Treatments	Days to 50% flowering	Number of branches (Days after planting)				Number of seeds/umblets		Seed yield (q/ha)
		30 DAP	60 DAP	90 DAP	Final Harvest	Primary	Secondary	
T1	55.60	4.67	7.33	8.07	8.40	42.23	29.60	6.53
T2	50.90	6.73	9.08	10.05	10.11	49.67	33.01	9.60
T3	55.20	5.60	7.69	8.62	8.75	46.07	30.03	7.26
T4	53.20	6.07	8.20	9.18	9.28	47.37	30.43	8.09
T5	54.80	5.80	7.79	8.88	8.97	46.30	30.23	7.51
T6	51.30	6.47	8.88	9.81	9.89	48.53	31.8	9.07
T7	52.30	6.27	8.72	9.64	9.71	48.30	30.63	8.86
T8	49.70	7.77	9.78	10.42	10.68	49.90	34.43	10.60
T9	50.20	7.33	9.51	10.31	10.44	49.87	34.33	10.29
T10	55.10	5.13	7.45	8.34	8.53	43.10	29.66	6.82
T11	50.70	7.00	9.34	10.12	10.30	49.73	33.53	9.94
T12	54.60	5.87	8.03	9.01	9.15	47.17	30.36	7.79
T13	52.80	6.07	8.49	9.43	9.54	47.47	30.50	8.54
T14	49.60	8.20	10.00	10.55	10.91	50.97	34.70	10.68
C.D. at 5%	NS	0.49	0.46	0.42	0.52	1.49	1.71	1.25

T1= Absolute control; T2= Recommended dose of fertilizers (N:P:K 80:40:40 kg/ha); T3= FYM 25t/ha; T4= Poultry manure 4t/ha; T5= Vermicompost 8t/ha; T6
= FYM 12.5t/ha+ poultry manure 2t/ha; T7= FYM 12.5t/ha+ vermicompost 4t/ha; T8= FYM 12.5t/ha+ poultry manure 2t/ha+ vermicompost 4t/ha; T9= FYM 12.5t/ha+ poultry manure 2t/ha+ *azotobacter+ phosphobacteria*; T10= FYM 12.5t/ha+ *azotobacter+ phosphobacteria*; T11= FYM 12.5t/ha+ vermicompost 4t/ha+ *azotobacter+ phosphobacteria*; T12= Vermicompost 8t/ha+ *azotobacter+ phosphobacteria*; T13= Poultry manure 4t/ha+ *azotobacter+ phosphobacteria*; T14= FYM 12.5t/ha+ Poultry manure 2t/ha+ vermicompost 4t/ha+ *azotobacter+ phosphobacteria*

Number of seeds/umblets: Maximum number of seeds per umblets (primary and secondary) were recorded in treatment T14 (Table 1) which was at par with treatments T8, T9, T11 and T2, while, the lowest was recorded in control. The synergistic impact of combined use of manure along with biofertilizers increased the availability of essential nutrients in a sufficient amount, increased the concentration of carbohydrates in the seed which act as a stock of carbohydrates. This might have resulted in an increased number of seeds per umblets. The results are supported with the findings of Ahamed (1999) in black gram, Bendegumbal *et al*. (2008).

Seed yield (q/ha): Maximum seed yield (q/ha) was observed under treatment T14 (10.68 q/ha) which was found statistically at par with treatments T8 (10.60 q/ha), T9 (10.29 q/ha), T11 (9.94 q/ha) and T2 (9.60 q/ha), while, it was found minimum (6.53 q/ha) under control (Table 1). This might be because of the availability of an appropriate amount of essential plant nutrients from an organic source, balanced C:N ratio, synthesis of auxin, growth substances and transformation of insoluble phosphate to a soluble form by Phosphorous Solubilizing Bacteria (PSB) possibly helped to increase the seed yield of carrot. Similar results were observed by Uikey *et al.* (2015); Negi *et al.* (2004); Sundara *et al.* (2004) in pea.

Standard germination (%): Standard germination (%) is an important factor that is related to the seed quality of the crop. Maximum seed germination (80.00 %, 77.00 % and 71.00 %) of fresh seeds, 3 and 6 months stored seeds, respectively were found in treatment T14 (FYM 12.5 t/ha + PM 2t/ha + VC 4t/ha + Azo + PSB) (Table 2) which might be due to better growth and availability of more photosynthates at the time of maturity, whereas, minimum germination percentage was found under control. Also, there was a significant difference among storage months with higher germination percentage observed in fresh seeds than 3 and 6 months stored seeds. The decline in germination percentage with storage may be accredited to the process of ageing, reduction of food reserves and decline in synthetic activity of embryo. Similar findings were reported earlier by Bendegumbal *et al*. (2007); Patil (2008) in capsicum, Bhatia and Pandey (1991); Jayathilake *et al*. (2003) in onion. There was no significant difference between the interaction of treatments and storage months.

Table 2: Effect of manure and biofertilizers on standard germination (%), vigour index-I, vigour index-II and electrical conductivity (µS/cm/seed) of fresh carrot seeds, 3 months and 6 months after their storage.

Treatments	Germination (%)			Vigour index-I			Vigour index-II			Electrical conductivity (µS/cm/seed)		
	Storage period (M)			Storage period (M)			Storage period (M)			Storage period (M)		
	Fresh seeds	3 months	6 months	Fresh seeds	3 months	6 months	Fresh seeds	3 months	6 months	Fresh seeds	3 months	6 months
T1	70.00 (56.77)	67.00 (59.94)	60.0 (51.92)	873.0	812.1	724.8	113.1	106.0	82.5	0.27	0.33	0.48
T2	75.33 (60.20)	72.00 (58.03)	65.3 (53.91)	1082.4	1015.3	887.4	134.7	126.8	99.5	0.16	0.21	0.36
T3	70.67 (57.18)	68.33 (55.73)	61.3 (51.53)	918.7	865.7	726.7	116.6	110.6	83.3	0.25	0.30	0.45
T4	74.00 (59.33)	71.00 (57.39)	63.0 (52.51)	1011.7	947.2	808.6	124.5	118.0	88.4	0.21	0.26	0.41
T5	72.67 (58.45)	70.33 (56.98)	62.3 (52.12)	953.4	898.7	763.6	120.0	114.5	85.3	0.24	0.28	0.43
T6	74.67 (59.76)	71.67 (57.82)	64.3 (53.31)	1054.1	989.3	855.1	130.7	123.2	96.7	0.18	0.22	0.37
T7	74.67 (59.76)	71.33 (57.62)	63.7 (52.91)	1050.7	982.5	842.0	129.8	122.8	94.1	0.19	0.24	0.39
T8	77.33 (61.56)	75.33 (60.20)	69.0 (56.15)	1152.4	1096.2	969.3	142.5	137.0	109.1	0.12	0.17	0.32
T9	77.33 (61.56)	74.00 (59.33)	67.7 (55.33)	1140.6	1067.9	940.5	141.9	132.9	105.2	0.14	0.20	0.35
T10	72.67 (58.45)	69.33 (56.35)	61.0 (51.33)	923.0	858.8	725.2	118.4	111.6	83.3	0.26	0.31	0.46
T11	75.33 (60.20)	73.00 (58.68)	67.3 (55.13)	1097.8	1041.5	926.4	137.2	130.2	104.0	0.15	0.20	0.36
T12	73.33 (58.88)	70.67 (57.18)	62.7 (52.32)	973.6	916.6	781.4	122.4	116.7	86.7	0.22	0.27	0.42
T13	74.00 (59.32)	71.33 (57.60)	63.0 (52.15)	1019.5	959.8	814.1	126.6	120.6	90.0	0.20	0.25	0.41
T14	80.00 (63.42)	77.00 (60.64)	71.0 (58.03)	1195.0	1110.0	1015.9	149.0	139.1	115.3	0.10	0.15	0.30
C.D at 5% M	0.48			42.7			5.2			0.013		
C.D at 5% T	1.05			113.2			15.8			0.027		
C.D at 5% M×T	NS			NS			NS			NS		

(Values in parenthesis are transformed values)

T1= Absolute control; T2= Recommended dose of fertilizers (N:P:K 80:40:40 kg/ha); T3= FYM 25t/ha; T4= Poultry manure 4t/ha; T5= Vermicompost 8t/ha; T6= FYM 12.5t/ha+ poultry manure 2t/ha; T7= FYM 12.5t/ha+ vermicompost 4t/ha; T8= FYM 12.5t/ha+ poultry manure 2t/ha+ vermicompost 4t/ha; T9= FYM 12.5t/ha+ poultry manure 2t/ha+ *azotobacter+ phosphobacteria*; T10= FYM 12.5t/ha+ *azotobacter+ phosphobacteria*; T11= FYM 12.5t/ha+ vermicompost 4t/ha+ *azotobacter+ phosphobacteria*; T12= Vermicompost 8t/ha+ *azotobacter+ phosphobacteria*; T13= Poultry manure 4t/ha+ *azotobacter+ phosphobacteria*; T14= FYM 12.5t/ha+ Poultry manure 2t/ha+ vermicompost 4t/ha+ *azotobacter+ phosphobacteria*

Vigour index-I and II: There were significant differences concerning vigour index-I and II among all the treatments and also during the storage period of 3 and 6 months (Table 2). Maximum vigour index-I and II of fresh seeds were recorded in treatment T14 (FYM 12.5t/ha + PM 2t/ha + VC 4t/ha + Azo + PSB) which was statistically at par with treatments T8, T9, T11 and T2. This might be due to fact that seeds of these treatments contained more stored food which might be used as a source for the vigour of seedling growth. These results are in corroboration with the finding of Patil (2008) in capsicum.

Vigour index-I and II decreased significantly with the advancement in the period of ageing in all the treatments, *i.e*., maximum vigour index-I and II of fresh seeds, 3 months and 6 months stored seeds found in treatment T14 (FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha + Azo + PSB). Similar results were reported by Priya and Rao (2008). Minimum vigour index-I and II of fresh seeds, 3 and 6 months stored seeds were found under control. There was no significant difference between the interaction of treatments and storage months.

Electrical conductivity (µS/cm/seed): Maximum EC for fresh seeds, 3 and 6 months stored seeds were found under control (Table 2), whereas, treatment T14 (FYM 12.5t/ha + PM 2t/ha + VC 4t/ha + Azo + PSB) showed the minimum EC for fresh seeds, 3 and 6 months stored seeds and the variation was found significant. Electrical conductivity of seed leachates was found low in fresh seeds (0.10 µS/cm/seed) in treatment T14 which increased with the ageing period of 3 and 6 months (0.15 µS/cm/seed and 0.30 µS/cm/seed), respectively. Increased electrical conductivity of seed leachates is always correlated with seed deterioration which in turn is related to the loss of vigour and viability. There was no significant difference between the interaction of treatments and storage months. These results are in line with the findings of Khan *et al.* (2003) in pea seeds and Maskri *et al*. (2003) in carrot seeds.

CONCLUSION

Based on the results of this experiment, treatment T14 (FYM 12.5t/ha + PM 2t/ha + VC 4t/ha + Azo + PSB) was found superior to other treatment combinations for all the estimated seed related parameters. Thus, application of farmyard manure @12.5 t/ha along with poultry manure @ 2 t/ha and vermicompost @ 4t/ha + Azo + PSB is suggested for obtaining higher seed yield and quality in terms of seedling characteristics of carrot seed crop in northern plains of India.

FUTURE SCOPE

Organic farming in the form of manures and biofertilizers is still at a nascent stage in India. Their effect on seed production of roots crops is under studied. Hence there is an ample scope for studying the effect of manures and biofertilizers on seed and seedling growth of various root crops for the welfare of farmers in India.

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Conflict of Interest. None.

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