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Short Communication

Effect of magnetopriming a non-imbibition method on quality enhancement of naturally aged carrot (*Daucus carota* L.) seed

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Carrot (*Daucus carota* L.) is one of the important root vegetable in umbelliferae family. It covers an area of 62.4 thousand ha in India with the production of 10.7 lakh tonnes (Saxena and Gandhi, 2015). Though carrot is root crop, it is mainly cultivated by seeds. The success of any crop production is mainly depending on quality of the seed. In general seed quality reduces with respect to storage period. Quality of aged seed can be enhanced by different seed enhancement treatment viz; priming (hydropriming, osmopriming, halo priming and solid matrix priming), coating and pelleting. All these are wet seed treatments or involves use of chemicals. In different priming methods, amount of water added to seed cannot be removed completely which affect the storability of primed seed. Therefore; an unconventional approach of seed invigoration which is magnetic seed treatment or magnetopriming may be the best alternative, because it is dry seed treatment method. But in magnetic seed treatment, strength of magnetic field (dose) and duration of exposure is very crucial. 180 mT [millitesla], 5 min in pea (Iqbal *et al.*, 2012), 200 mT, 1 hr in cucumber (Bhardwaj *et al*., 2012), 80 mT, 10 min in radish (Krawiec *et al.*, 2013) and 40 mT, 20 min in tomato (Jedlicka *et al.*, 2014) were conclude as effective magnetic strength and treatment duration respectively. In this study, we made an attempt to standardize the magnetic field strength and treatment duration for seed quality enhancement in naturally aged carrot seed.

The carrot cv. Pusa Rudhira seeds produced at Seed Production Unit, ICAR-Indian Agricultural Research Institute, New Delhi during 2012-13 were used for magnetic seed treatment, after one year of storage at ambient condition. The average germination percentage after harvesting and one year after ambient storage was 80 and 65% respectively and moisture content was 7.8% and 7.0%, respectively. Seeds without visible defects, insect damage and malformation were selected and used for the experiments.

An electromagnetic field generator "Testron EM-60" with variable magnetic field strength (50-300 mT) with a gap of 10 cm between pole pieces was used for seed treatment. The seeds of carrot were exposed to the static magnetic field strength of 50, 100 and 150 mT in a sample holder which was cylindrical in shape and made of non-magnetic thin transparent plastic sheet. Visibly sound, mature and healthy seeds were kept inside the plastic container between the poles of the electromagnet having uniform magnetic field for various duration of 10, 20, 30, 40 50, 60, 90 and 120 minutes along with control (0 min). While exposing seeds to higher magnetic strength and long duration treatments, it is advisable to carry out one treatment per day to avoid mechanical failure of machine.

The per cent germination of the treated seeds was determined by using "between papers" method (ISTA, 2012). Four hundred seeds in four replications of 100 seeds each were placed between two layers of moist germination papers and placed in the germination incubator at 20ÚC. After 14days, the seeds were evaluated for normal, abnormal seedling, ungerminated and dead seeds. Germination-percentage was worked out on the basis of normal seedling only and was transformed into arcsine values for statistical analysis.

Speed of germination was estimated by counting the number of seedlings emerged on each day till final count (14 Days). The speed of germination was calculated as per Maguire (1962).

Speed of germination $=\Sigma n/t$

Where n is number of seeds newly germinated at time t and t is days from sowing.

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Ten normal seedlings from each replicate were taken at random and the shoot and root length were measured. Seedlings were dried overnight in an oven set at 80ºC and weighed together after drying. Seedling vigour was calculated based on methods given by Abdul- Baki and Anderson (1973).

Vigour index I = Germination % × Seedling length (cm) (Root + Shoot length)

Vigour index II = Germination % × Seedling dry weight (mg per seedling)

The data recorded were subjected to two factor factorial Completely Randomized Design analysis. The computer software used was AgRes version 3.01.

In this study, magnetopriming was significantly influencing all the physiological parameters of germinating seed. Seeds exposed to magnetic strength of 50 mT recorded the highest germination (70%), speed of germination (12.94), seedling length (14.91 cm), dry weight of seedling (1.3 mg), vigour index I (1041) and vigour index II (91). Significant reduction in all the physiological parameter was observed in seeds exposed

Table.1. Effect of magnetic treatments on seed quality enhancement in carrot cv. Pusa Rudhira

Treatments	G (%)	SG	SL	DW	Vigour index	
					I	II
M1 (50 mT)	70 (56.56) a	12.94 a	14.91 a	1.30 a	1041 a	91 a
M2 (100 mT)	68 (55.80) b	12.64 b	14.39 b	1.25 b	986 b	86 b
M3 (150 mT)	67 (54.61) c	11.88 c	14.07 c	1.23 c	937 c	82 c
CD (0.05)	**0.73**	**0.07**	**0.10**	**0.02**	**23.4**	**1.82**
SE(d)	**0.35**	**0.03**	**0.05**	**0.01**	**11.4**	**0.89**
D1 (10 min)	67 (54.71) de	12.35 de	14.19 d	1.26 cd	947 d	84 e
D2 (20 min)	70 (56.45) b	12.77 b	14.38 c	1.28 c	1001 c	89 bc
D3 (30 min)	72 (58.24) a	12.98 a	15.22 a	1.37 a	1101 a	99 a
D4 (40 min)	71 (57.18) a b	12.72 b	15.11 a	1.34 b	1068 b	95 a
D5 (50 min)	70 (56.77) b	12.55 c	14.85 b	1.25 cde	1040 b	87 bcd
D6 (60 min)	69 (56.04) bc	12.46 cd	14.55 c	1.23 def	1002 c	85 de
D7 (90 min)	67 (55.12) cd	12.32 e	14.19 d	1.22 efg	956 d	82 e
D8 (120 min)	64 (52.81) f	11.93 f	13.84 e	1.21 fg	879 e	77 f
D9 (0 min)	65 (53.71) ef	12.30 e	13.77 e	1.20 g	895 e	78 f
CD (0.05)	**1.25**	**0.12**	**0.18**	**0.03**	**40.5**	**3.16**
SE(d)	**0.61**	**0.06**	**0.09**	**0.02**	**19.7**	**1.54**
M1D1	70 (66.77)	13.13 cd	14.75 def	1.30	1033bcde	91 df
M1D2	72 (58.03)	13.43 b	15.02 cd	1.31	1081 b	94 cd
M1D3	74 (59.32)	13.66 a	15.99 a	1.47	1183 a	109 a
M1D4	73 (58.35)	13.19 c	15.85 a	1.41	1149 a	102 b
M1D5	71 (57.08)	12.95 de	15.36 b	1.29	1083 b	91 dfg
M1D6	71 (57.08)	12.85 ef	15.08bc	1.26	1063bc	89 dfgh
M1D7	69 (56.14)	12.71 fg	14.48fgh	1.24	999 def	86 ghijk
M1D8	64 (52.81)	12.30 h	13.86 kl	1.24	880 h	78 lmno
M1D9	65 (53.71)	12.30 h	13.77lm	1.20	895 h	78 lmno
M2D1	67 (54.61)	12.31 h	14.29 hi	1.26	950fg	84 hijk
M2D2	71 (57.08)	12.60 g	14.42gh	1.27	1017cde	90 dfg
M2D3	72 (58.13)	13.24 bc	14.98cde	1.34	1078 b	96 c
M2D4	71 (57.39)	13.10 cd	14.97cde	1.32	1063bc	94 c
M2D5	71 (57.08)	12.87 ef	14.76 def	1.24	1041bcd	87 fghij
M2D6	69 (55.84)	12.83 ef	14.37 hi	1.24	984ef	85 hijk
M2D7	68 (55.53)	12.62 g	14.11ijk	1.22	959 f	83 ijkl
M2D8	64 (53.11)	11.86 ij	13.85 kl	1.21	886 h	77 no
M2D9	65 (53.71)	12.30 h	13.77lm	1.20	895 h	78 lmno
M3D1	64 (52.81)	11.61 l	13.54 m	1.23	860 h	78 mno
M3D2	66 (54.31)	12.29 h	13.70lm	1.25	904gh	83 ijklm
M3D3	71 (57.39)	12.04 i	14.70efg	1.31	1043bcd	93 cd
M3D4	69 (55.84)	11.89 ij	14.50fgh	1.29	993 def	88 dfgh
M3D5	69 (56.14)	11.84 jk	14.43gh	1.22	996 def	84 hijk
M3D6	68 (55.22)	11.69 jkl	14.22hij	1.21	960 f	81 klmn
M3D7	65 (53.71)	11.65 kl	13.98jkl	1.20	908gh	78 mno
M3D8	63 (52.51)	11.63 l	13.81klm	1.20	870 h	76 o
M3D9	65 (53.71)	12.30 h	13.77lm	1.20	895 h	78 lmno
CD (0.05)	**NS**	**0.20**	**0.30**	**NS**	**70.18**	**5.48**
SE(d)	**1.06**	**0.10**	**0.15**	**0.03**	**34.20**	**2.67**

G (%) = Germination percentage; SG = Speed of germination; SL = Seedling length (cm); DW= Dry weight (mg seedling^{-1}). Values in parenthesis are arcsine transformed values. Separation done by Duncan's Multiple Range Test.

to higher magnetic field strength (150 mT). It shows higher magnetic strength was not in favour of seed quality enhancement in carrot (table 1).

Among the treatment durations, seeds exposed to magnetic field for a period of 30min recorded higher germination (72%), speed of germination (12.98), Seedling length (15.22 cm), dry weight of seedling (1.37 mg), vigour index I (1101) and vigour index II (99). Treatment duration of 40 min was showing on par performance with 30 min with respect to germination (71%), seedling length (15.11 cm) and vigour index II (95). Seeds exposed to 120 min recorded lower germination (64%) and speed of germination (11.93) than control (65% and 12.3 respectively). This indicated that exposure of seed in magnetic field for longer duration was not enhancing but reducing the seed quality.

The interaction effect of magnetic field strength and treatment duration showed enhanced speed of germination (13.66), seedling length (15.99 cm), vigour index I (1183) and vigour index II (109) at 50 mT×30 min. Higher and on par seedling length (15.85 cm) and vigour index I (1149) were recorded in 50 mT×40 min and 50 mT×30 min. Both germination percentage and seedling dry weight were not significantly influenced by interaction effect of magnetic strength and treatment duration. The interaction effect of 100 mT×120 min and 150 mT×120 min recorded reduced performance than control with respect to per cent germination, speed of germination, vigour index I and vigour index II (Table 1).

Magnetic priming enhances the concentration of ions, free radicals and electrical charges physically without any alteration/degradation in the chemical composition of seed. Finally, it makes the membranes more permeable. This may be one of the reasons for increase in speed of germination of treated seeds. Free movement of ions in treated seeds activates the metabolic pathways by enhancing the biochemical and physiological feedback (Zia- ul- Haq*et al*., 2012). This may be the reason for improved germination of magnetoprimed seeds. According to a few reports the magnetic field strength, exposure time and modulation are important to realize the benefits of magnetic treatments (Iqbal *et al*., 2012; Tkalec *et al*., 2009).

Magnetic seed treatment is a physical and dry seed treatment, in which seed is exposed in magnetic field for specific period of time. In this study, the field strength and duration of exposure in magnetic field was standardized for maximum enhancement of seed quality parameter for one year old carrot seed under laboratory conditions. In conclusion, better seed enhancement was observed at 50mT magnetic strength for 30min and their interaction. Exposure of seed in higher magnetic field and for longer duration resulted in reduced seed quality in carrot.

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Short Communication

A study to identify research priorities in the area of conservation of vegetable germplasm and variety development

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Vegetables are rich source of minerals, vitamins, vegetable fiber and contain fair amount of carbohydrate and protein (Singh *et al.* 2012). Vegetables contain high amount of nutraceuticals which helps fight diseases, hence called protective food. Over the last two decades it has been observed that, there is a change and shift in food habits of Indian population and consumption of fruits and vegetables have been increased, but the productivity of vegetables is 17.3 t/ha which is not sufficient to meet projected requirement of producing 225 mt of vegetables by the year 2030 (Roy *et al*. 2016). To increase productivity superior varieties of vegetables are required which are resistant to disease pest and other abiotic and biotic stresses and contain high nutritive value. Conventionally cultivated and wild species of vegetables are known to be good carrier of genes responsible for disease-pest resistance, climate resilience and enriched with high amount of nutraceuticals. But in modern times farmers have stopped cultivating conventional vegetable varieties as they yield less, even many varieties have been extinguished. It has become a threat for future vegetable breeding programme. So conservation of vegetable genetic resources and development of superior varieties is very important in vegetable sector. Research organizations are conducting research in this line in our country. But the researches are unorganized. Database is not maintained properly, accession of information regarding genetic information and accession of germplasm is not easy. Repetition of same research conducted which results in exploitation of resources and energy. With this background, a study was designed with the objective to identify the priority issues in the sector of conservation of vegetable genetic resources and variety development.

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The study was conducted through online survey. The survey questionnaire had been sent to 50 scientists of ICAR institutes, 50 teachers of SAUs and 50 subject matter specialists of KVKs sampled purposively who deal with vegetable crops, for their response. Among them 75 respondents replied from 22 different states representing different agro-climatic regions of India (Table 1). The questionnaire contained objective type of questions related to problems in conservation of plant genetic resources and variety development in vegetable sector and the respondents were asked to score each problem in a five point continuum ranging most important (5), important (4), undecided (3), less important (2) and not important (1) as they perceived. The total score for each problem was obtained by summing the scores given by 75 respondents.

For obtaining weightage of each problem, 10 subject experts sampled randomly from the concerned fields were asked to score the problems in a three-point continuum ranging most urgent, urgent and less urgent and give a score of 3, 2 and 1 respectively. Those 10 Subject experts had not been selected as respondents in the study. The weightage for each problem was calculated with the following formula:

$$\text{Weightage} = \frac{\text{Obtained score}}{(\text{Maximum possible score}) - (\text{Minimum possible score})}$$

Weighted sum was calculated by multiplying weightages of the individual problems with the total score obtained and the weighted average (WA) was obtained by dividing the weighted sum with the total number (75) of respondents. Linear Regression analysis was done among the problems considering rank 1 problem as dependent variable while others as independent to know in what proportion (R^2 value) the independent variables influence the dependent variable. The â-value represents 1 unit change in the corresponding independent variables will change the dependent variable equal to the corresponding â-value.