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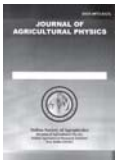

Research Article

Effect of Magnetic, Electric and Electromagnetic Treatments on Growth and Yield Parameters in Buckwheat (*Fagopyrum esculentum*)

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ABSTRACT

The study demonstrated that the application of magnetic, electric and electromagnetic treatments had a significant influence on the germination and early growth of buckwheat. The experiment was conducted at the Department of Genetics and Plant Breeding, Naini Agricultural Institute aimed to evaluate the effects of electric, magnetic, and electromagnetic treatments on buckwheat growth and yield parameters. Various treatments with different intensities and durations were applied to buckwheat seeds, including magnetic flux intensities (50 mT, 75 mT, 100 mT, 125 mT) and AC electric current (75 mA, 100 mA, 125 mA).T12 treatment (125 mT + 75 mA for 3 min 30 sec) significantly improved seed yield per plot, treatment T10 showed the highest field emergence whereas T1 and T12 treatments achieved maximum germination per cent (97% respectively) and T9 treatment excelled in vigour index-I, vigour index-II, shoot length, and seedling length. The exposure of electromagnetic field (EMF) treatments has potential in enhancing seed germination. Overall, the study suggests that electric, magnetic, and electromagnetic treatments can enhance buckwheat production.

Key words: Electric current, Magnetic field, Electromagnetic field, Seedling parameters

Introduction

Buckwheat has been a crop of secondary importance in many countries and yet it has persisted through centuries of civilization and centers the agriculture of nearly every country where cereals are cultivated. Buckwheat *(Fagopyrum esculentum*) which is originated from northern China, which belongs to Polygonaceous family with chromosome no. 2n=16. Buckwheat originated in Central Asia, but South China is the place where it was first domesticated between 400 to 5000 years ago (Gondola and Papp, 2010). As a result, China is regarded as the birthplace of buckwheat and has an abundance of buckwheat genetic resources. India, Nepal, Bhutan, China, Canada, Mongolia, North Korea, Far Eastern Russia and Japan are the main countries, where buckwheat is grown. But during the first half of 20th century, buckwheat production fell, particularly in Russia and France.

Buckwheat is distributed from hilly areas of Jammu and Kashmir, Uttarakhand, Himachal Pradesh, Uttar Pradesh, west Bengal, Sikkim, Meghalaya, Arunachal Pradesh, it is sporadically cultivated in Nilgiris and Palani hills of Tamil Nadu and Kerala. In India area covered under production of buckwheat is 1.12Mha with the production of 1.19Milliontonnes while productivity was 3735 kg/ha and average productivity of 15-18 q/ha (Rangappa *et al*., 2023). In Uttar Pradesh it is grown on 0.14

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lakh ha area with total production of 44.7 lakh tons and average productivity of 2252 kg/ha during 2021-2022 (Directorate of Economics and Statistics, DAC&FW 2020-21).

Buckwheat is a short seasonal crop that needs 10-12 weeks to mature (90-120 days crop). It is a herbaceous plant from the Polygonaceae family and its seeds are edible. Buckwheat is cultivated from its grain seed and also as a cover crop. Buckwheat is also known for only requiring moderate soil fertility to grow. Buckwheat thrives in cool, moist climates, it is not frost tolerant, because of its short growing period. High temperature and dry condition during flowering may cause some flower blast and lower yields. Cool evening temperature and high humidity favor buckwheat growth. Buckwheat can be grown on a wide range of soil types but it is suited to light and medium textured soils, such as sandy loam, loam and silt loam. Buckwheat is acid tolerant as oats and potato with limited soil pH of 5.

Though buckwheat is a minor crop it has tremendous nutritional and medicinal value. Buckwheat has high nutritional value. Starch is the major component of buckwheat ranges from 59-69% of grain composition with 15-25% of amylose and 7-35% resistant starch and remaining portion is amylopectin. The grain contains 11-15% protein, 7.4g fat, 2.4% mineral matter, 15% fiber,1.5-3.7% lipids, 355 kcal energy (Narsin, 1979 and Ram *et al.*, 1979). The protein of buckwheat is of excellent quality and is high in essential amino acid lysin, unlike common cereals. This rutin extraction is used in medicines. Buckwheat is of two types of common buckwheat (*Fagopyrum esculentum*) and Tartary buckwheat (*Fagopyrum tartaricum*), are most widely grown for food The development of innovative technologies for improving germination, seedling growth and resistance against abiotic and biotic stress factors has recently reached high importance. The use of physical techniques such as non-thermal plasma, electromagnetic fields (EMFs) and ultrasound have received much attention, since these methods are considered safer and more environmentally friendly. It has been reported that both magnetic and electric fields can improve the seed quality in numerous crops. The positive impacts of such treatments Includes better seed germination and seedlings growth as well as higher yield. Seedlings obtained from treated seeds are more resistant to unfavorable environmental conditions.

In the recent times the crop production requirement is more due to increase in human population. Due to industrialization, the environment has become poisoned and polluted with harmful chemicals.

In recent years there has been lot of research on the effect of magnetic, electric and electromagnetic fields on seed germination, plant growth, and change in yield (Radhakrishan *et al*., 2013). Now-a-days electromagnetic fields are used as non-chemical methods in agriculture. It has been perceived that electric and magnetic fields cause physiological - biochemical changes in the seeds (Putincev *et al.*, 1997).

The application of magnetic fields in the agriculture sector has emerged as an efficient method to stimulate the plant biological characteristics. Magnetic field pre-sowing seed treatment is eco-friendly as well as non-polluting the soil and environment (Adesola *et al*., 2016; Babarinde and Onyiaocha, 2016).

The term electromagnetic fields cover all the fields emitted by nature and man-made sources. Electromagnetic fields are a part of environmental factors which effects have attracted considerable attention. The enhancement of growth due to magnetic field exposure appears to have been confirmed by many scientists.

Magnetic, Electric and Electromagnetic can play a significant role in boosting agricultural productivity which is a subsidiary approach towards chemical free and environmentally friendly agriculture. Magnetic treatments interact with seeds and plants and accelerate metabolism, which leads to an improved germination. Electromagnetic field seed treatment is a promising technique in agriculture that involves treating seeds with electromagnetic fields to enhance germination rate and growth. Electromagnetic treatments have several benefits which include germination rate, seedling growth, increase in yield, reduction in use of chemicals. These are cost effective and environmental friendly approach which can be easily applied on large scale. So far very less attention has been given to this area which has the potential to transform agriculture in our country.

Materials and Methods

The study was conducted in the Field Experimentation Center and Seed Testing Laboratory (Uttar Pradesh Notified Seed Testing Laboratory) of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during *Rabi* 2023-2024.

Observations recorded

The observations recorded for Growth and yield parameters includes field emergence %, plant height (cm), leaf area (cm^2), petiole length (cm), days to first flowering, number of branches per plant, number of seeds per plant, seed yield per plot (g), seed yield per hectare (q/ha), biological yield (g), economical yield (g), harvest index (%), seed index (1000 seed weight)

Observations recorded for seedling parameters are germination (%), root length (cm), shoot length (cm), seedling length (cm), dry weight, fresh weight, Vigor index-I, Vigor index-II.

Result and Discussion

Seedling parameters

Seeds were subjected to magnetic, electric and combination field seeds treatment improved all seedling characters and reduction in ageing was found. Improvement in seedling characteristics such as germination percentage, shoot and root length, fresh and dry weight, vigor index-I and vigor index-II (Jyothi *et al.*, 2018)

Germination (%): The germination percentage ranges from 82 to 97% with the grand mean of 91.62. It was found that the maximum germination percent 97% was under seed treatment T1 (50 mT for 3 min) and minimum germination percent 82.25% was under seed treatment was under T11 (100 mT +125 mA for 5 min + 60 sec). Due to electromagnetic exposure on the surface of the seed minute cracks were formed. These minute hair cracks make it permissible for the exchange of gases and water for the environment to the seeds. Enzymes and biochemicals get triggered due to the exchange of these vital factors and the process of germination inside the seeds gets activated (Singh *et al.*, 2021).

Shoot length (cm): It is observed that the mean values of shoot length ranged between 5.53 to 8.60 cm. Maximum number of shoot length was recorded in T10 (75 mT +100 mA for 3 min + 30 sec) (8.60) followed by T9 (50 mT + 75 mA for 3 min+ 30 sec) (7.63 cm) and minimum number of shoot length is recorded in T11 (100 mT + 125 mT - 5 min + 60 sec). This static field positively influenced plant growth by increasing the shoot length and root length. Application of magnetic fields of extremely low frequencies positively effects seed germination, shoot development, plant length, fresh weight (Cakmak *et al.*, 2010; Vasisth *et al*., 2017).

Table 1. Seed treatments details

S.No.	Treatments	Chemicals	Intensity	Duration
1.	T0	Control	-	-
2.	T1	Magnetic field	50 mT	3 min
3.	T2	Magnetic field	75 mT	3 min
4.	T3	Magnetic field	100 mT	5 min
5.	T4	Magnetic field	125 mT	3 min
6.	T5	Electric current	75 mA	30 sec
7.	T6	Electric current	75 mA	60 sec
8.	T7	Electric current	100 mA	30 sec
9.	T8	Electric current	125 mA	60 sec
10.	T9	Magnetic field+ Electric current	50 mT +75 mA	3 min+30 sec
11.	T10	Magnetic field+ Electric current	75 mT +100 mA	3 min +30 sec
12.	T11	Magnetic field+ Electric current	100 mT +125 mA	5 min+60 sec
13.	T12	Magnetic field+ Electric current	125 mT +75 mA	3 min+60 sec

Root length (cm): It was observed that the mean values of root length ranged between 10.95 to 15.76 cm. Maximum number of root length 15.65 cm was recorded T9 (50 mT + 75 mA for 3 min + 30 sec) followed by 15.65 cm in T8 (125 mA for 60 sec) and minimum number of root length 10.95 cm was recorded in T11 (100 mT + 125 mA for 5 min + 60 sec). Better root growth and development in younger seedling growth affected by Magnetic field might leads to better root system through enhancement in leaf area and dry weight and increase in photosynthetic rates due to the grater interception of light and greater amount of assimilates available for vegetative growth . Increasing the exposure time caused the length of root to be decreased (Rathod *et al.*, 2016; Sedigi *et al.*, 2013).

Seedling length (cm): It was observed that the mean values of seedling length ranged between 16.48 to 23.39 cm. The maximum number of seedling length 23.39 cm was recorded in T9 (50 mT + 75 mA for 3 min + 30 sec) followed by 22.66 cm T8 (125 mA for 60 sec). Minimum values 16.48 cm was recorded in T11 (100 mT + 125 mA for 5min + 60 sec). Increased physiological activity due to greater absorption of moisture by treated seeds may be responsible for increase in seedling length (Joshi *et al.*, 2017).

Fresh weight (g): Fresh weight ranged between 0.65 to 1.30 g. Maximum fresh weight 1.30g was recorded in T12 (125 mT + 75 mA for 3 min + 60 sec) followed by 1.30 in T10 (50 mT + 75 mA for 3 min + 30 sec) and minimum fresh weight 0.65 g was recorded in T5 (75 mA for 30 sec). similar results was observed in Brinjal by (Jyothi *et al.*, 2018).

Dry weight (g): Maximum dry weight 0.82 g was recorded in T10 (75 mT + 100 mA for 3 min + 30 sec) and minimum dry weight 0.02 g was recorded in T3 (100 mT for 5 min). Increased physical activity due to greater absorption of moisture by treated seeds may be responsible for an increase in dry weight. Effects of electromagnetic field with low frequency on an oak tree reported the increase in the height of main stem, dry weight, and germination rate (De souza *et al.*, 2006).

Vigor index I: Maximum vigor index I 2140.23 was under T9 (50 mT + 75 mA for 3 min + 30 sec) followed by 2136 in T10 and minimum vigor index I 1356 was under T11 (100 mT +125 mA for 5 min + 60 sec). Increased physiological activity due to greater absorption of moisture by treated seeds may be responsible for increase in vigor index and the vigor index increase in electric field (Vasisth *et al.*, 2013).

Table 2. Analysis of variance for seedling parameters

Parameters	SS	MSS	F-Value
Germination per-cent	1033.8	86.15	5.181
Shoot length	37.05	3.084	12.79
Root length	132.58	11.0485	8.217
Seedling length	273.21	22.76	8.253
Fresh weight	2.55	0.213	126.63
Dry weight	0.069	0.0058	185.45
Vigor index-I	2968981.13	247415.09	7.8791
Vigor index-II	617.33	51.44	136.38

Indicates SS-sum of squares, MSS-Mean sum of squares.

Vigor index II: The maximum amount of vigor index II 14.15 was under T9 (50 mT + 75 mA for 3 min + 30 sec) followed by 12.29 in T6 (75 mA for 60 sec). Minimum vigor index II 1.94 was recorded under T3 (100 mT for 5 min). Increased physiological activity due to greater absorption of moisture by treated seeds may be responsible for increase in vigor index and the vigor index increase in electric field (Vasisth *et al.*, 2013; Biswas *et al*., 2016).

Field parameters

Field Emergence (%): Maximum germination percentage is observed 85% was observed in T10 (75 mT+100 mA) for 3 min + 30 sec followed by 81% in T1 (50 mT for 3 min). and minimum field emergence recorded 56% was recorded in T8 (125 mA for 60 sec). When seeds were exposed to electromagnetic exposure, minute cracks were formed on the surface of the seed coat. These minute hair cracks make it permissible for the exchange of gases and water from the environment to the seeds which enhances the maximum field emergence in buckwheat (Singh *et al.*, 2021). Similar results were reported by Krishna *et al.* (2017).

Plant height (cm): It was observed from the data represented in Table 4 that there was enhancement

Table 3. Mean performance of seedling parameters after magnetic, electric and electromagnetic treatments in buckwheat

	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Fresh weight (gm)	Dry weight (gm)	Vigour index-I	Vigour index-II
T0	91.25	6.20	12.20	18.15	0.77	0.05	1652	4.56
T1	97.00	7.18	14.13	21.55	0.85	0.06	2090	5.58
T2	91.50	6.05	11.95	17.80	0.72	0.06	1625	5.49
T3	85.75	6.64	12.80	20.14	1.21	0.02	1723	1.94
T4	91.50	7.10	14.23	20.83	1.05	0.04	1905	3.66
T5	95.50	6.75	14.48	21.23	0.65	0.05	2027	5.01
T6	94.50	5.58	12.30	17.88	0.74	0.13	1686	12.29
T7	94.25	6.65	15.28	21.93	1.06	0.06	2069	5.41
T8	85.00	7.01	15.65	22.66	0.75	0.07	1925	6.17
T9	91.25	7.63	15.76	23.39	1.08	0.16	2140	14.15
T10	95.00	8.60	13.88	22.48	1.30	0.12	2136	11.17
T11	82.25	5.53	10.95	16.48	0.85	0.06	1356	4.93
T12	96.25	5.70	11.10	16.80	1.31	0.08	1617	7.41
Mean	91.62	6.66	13.44	20.10	0.95	0.07	1842.81	6.75
Minimum	82.25	5.53	10.95	16.48	0.65	0.02	1356.43	1.94
Maximum	97.00	8.60	15.76	23.39	1.31	0.16	2140.23	14.15
S.Em	2.04	0.25	0.58	0.83	0.02	0.003	88.60	0.31
SE.d	2.88	0.35	0.82	1.17	0.03	0.004	125.30	0.43
CD at 5%	5.83	0.70	1.66	2.38	0.06	0.008	253.45	0.88
C.V.	4.45	7.37	8.63	8.26	4.33	7.63	9.62	9.10

in plant height at 85 days when seeds are exposed to electric current and magnetic field. Maximum plant height 45.29 cm was recorded in T5 (75 mA for 30 sec) followed by 43.33 cm in T3 (125 mT for 5 min) and minimum plant height 33.09 cm was recorded in T1 (50 mT for 3 min), this is due to ion accumulation mechanism and internal auxin production. Similar results were reported by Joseph *et al.* (2020).

Leaf area (cm^2): It was observed from the data represented in Table 4 that there was enhancement in the leaf surface area. maximum leaf surface area 11.28 cm^2 was recorded in T7 (100 mA for 30 sec) and minimum 6.83 cm^2 recorded in T0 control. Similar results were reported by De Souza *et al.* (2006).

Days to first flowering: From the present investigation it was observed that minimum days taken for first flowering 47 days was under T3 (100 mT for 5 min) followed by 48 days in T5 (125 mT for 3 mins) and maximum 61 days in T4 (125 mT for 3 mins).

Number of branches per plant: Maximum number of branches per plant 4.83 was recorded in T3 (100 mT for 5 min) followed by 3.67 in T12 (125 mT + 75 mA for 3 mins + 60 sec), and minimum number of branches per plant 2.13 in T2 (75 mT for 3 min). Similar results were reported by Abdolmaleki *et al.* (2013).

Number of seeds per plant: Maximum number of seeds 51.60 was recorded in T0 control followed by 4.67 in T7 (100 mA for 30 sec) and minimum number of seeds per plant 33 in T2 (75 mT for 3 mins).

Seed yield per plot (g): It was observed that there was enhancement in seed yield per plot when seeds were exposed to magnetic and electric treatment. Maximum seed yield per plot is 8.64 g in T12 (125 mT + 75 mA for 3 min + 60 sec) followed by 8.05 g in T11 (100 mT + 125 mA for 5 min + 60 sec).

Table 4. Analysis of variance for different field parameters of buckwheat

Parameters	SS	MSS	F-Value
Field emergence	88.76	44.38	5.87
plant height	2.857	1.42	1.104
Leaf area	0.444	0.222	0.0161
DFF	9.3846	4.6923	0.786
NBPP	0.139	0.0695	0.9698
NO. of seeds per plant	70.50	35.25	2.32
Seed yield per plot	0.3255	0.162	1.162
Seed yield per hectare	0.184	0.092	0.305
Biological yield	0.185	0.092	0.3059
Harvest index	9.005	4.502	0.15
Test weight	0.8193	0.409	1.069

Indicates DFF-Days to first flowering, NBPP-No. of branches per plant, MSS-Mean sum of squares, SS-sum of squares

Minimum seed yield per plot recorded in T1 (2.99 g) (50 mT for 3 min). This might be attributed to the favorable germination, higher growth and enhances flowering, fruit formation and yield.

Seed yield per hectare (q): It was observed that there was enhancement in seed yield per hectare when seeds are exposed to magnetic and electric treatment. Maximum number of seed yield per hectare 6.40q was recorded in T12 (125 mT + 75 mA for 3 min + 60 sec) followed by 5.96 q in T11 (100 mT + 125 mA for 5 mins for 60 sec) and minimum seed yield per hectare 2.21 q in T1 is (50 mT for 3 min).

Biological yield (q): From the data observed that there was known enhancement in biological yield when seeds were exposed to magnetic and electric treatments. Maximum Biological yield 11.25 q was recorded in T7 (100 mA for 30 sec) and minimum 5.27 q in T1 (50 mT for 3 min). Similar results were reported by Ivankov *et al.* (2012).

Harvest index (%): From the present experiment, it was observed that the maximum harvest index 110.44% was noticed in T8 (125 mA for 60 sec) followed by 104.47% in T6 (75 mA for 60 sec) and minimum harvest index 54.91% in T1 (50 mT for 3 min). The observed increase in harvest index under T8 indicates a strong positive effect of higher

Table 5. Mean performance of growth parameters

Treatments	Field emergence (%)	Plant height @ 30 DAS (cm)	Plant height @ 60 DAS (cm)	Plant height @ 85 DAS (cm)	Leaf surface area (cm^2)	Days to first flowering	No. of branches per plant
T0	65.00	12.35	28.77	38.43	6.83	51.67	2.31
T1	83.00	10.35	24.67	33.30	7.56	48.33	2.27
T2	83.00	13.21	29.07	39.63	7.77	51.33	2.13
T3	66.33	14.04	33.80	43.50	8.75	47.33	4.80
T4	75.00	13.21	32.77	40.80	8.53	61.67	2.87
T5	73.00	12.33	36.50	45.33	8.48	48.00	3.07
T6	73.67	12.57	34.40	43.97	11.11	59.00	3.53
T7	81.33	11.67	34.63	41.97	10.93	51.33	3.47
T8	56.67	10.65	29.50	40.20	8.65	48.00	3.10
T9	68.00	10.57	32.60	40.93	7.98	53.33	3.70
T10	85.00	11.02	32.13	40.60	10.33	48.00	2.53
T11	62.67	11.69	31.20	39.93	10.97	48.00	2.53
T12	79.33	12.59	31.23	41.37	10.53	48.00	3.67
Mean	73.23	12.02	31.64	40.77	9.11	51.08	3.07
Minimum	56.67	10.35	24.67	33.30	6.83	47.33	2.13
Maximum	85.00	14.04	36.50	45.33	11.11	61.67	4.80
S.EM	1.59	0.07	0.69	0.66	0.15	1.41	0.15
SE.d	2.24	0.10	0.98	0.93	0.22	2.00	0.22
CV	3.75	1.06	3.78	2.79	2.92	4.78	8.71

Table 6. Mean performance of yield parameters in buckwheat

Treatments	No. of seeds per plant	Seed yield per plot (g)	Seed yield per hectare (q)	Biological yield (q)	Harvest index (%)	Test weight (1000 seed weight) (g)
T0	51.60	4.65	3.44	7.09	65.71	15.53
T1	36.47	2.99	2.21	5.27	56.75	15.00
T2	33.00	4.37	3.23	6.69	65.72	15.90
T3	45.77	7.18	5.32	9.86	59.65	16.17
T4	36.70	4.36	3.23	7.18	61.02	15.43
T5	46.97	6.53	4.84	9.14	72.37	16.23
T6	35.53	5.91	4.38	8.42	102.06	17.57
T7	47.67	7.58	5.61	11.25	68.29	16.26
T8	35.23	6.16	4.56	8.62	110.65	16.43
T9	33.17	7.05	5.22	9.67	72.56	16.10
T10	45.57	6.63	4.91	9.31	72.51	15.37
T11	39.87	7.98	5.91	10.79	74.78	14.77
T12	41.57	8.64	6.40	8.58	100.85	16.00
Mean	40.70	6.16	4.56	8.61	75.61	15.90
Minimum	33.00	2.99	2.21	5.27	56.75	14.77
Maximum	51.60	8.64	6.40	11.25	110.65	17.57
S.EM	2.25	0.22	0.16	0.32	3.12	0.36
SE.d	3.18	0.31	0.23	0.45	4.41	0.51
CD	6.57	0.63	0.47	0.93	9.10	1.04
CV	9.57	6.08	6.09	6.40	7.14	3.89

electrical current intensity and exposure time. This may be attributed to the increased nutrient transport and Photosynthetic efficiency associated with such treatments. Similar results were reported by Almaghrabi and Eibeshehy (2012).

Test weight: It was observed that there was enhancement in test weight when seeds were exposed to magnetic field, electric current and electro-magnetic field treatments. The maximum test weight 17.57 g was recorded under T6 (75 mT - 60 sec) followed by 16.43 g in T8 (125 mA - 60 sec) whereas minimum test weight 14.77 g was recorded T2 (75 mT - 3min).

Discussion

Growing plants are constantly affected by natural and man-made magnetic fields. Technological advancement and the increasing use of different electric devices have greatly increased the level of electromagnetic fields (EMFs) in the environment. The purpose of this study was to observe the effect of magnetic, electric and electromagnetic treatments in growth, yield and seedling parameters on Buckwheat. During field conditions there was improvement in field emergence where there was significant improvement in the plant growth. In present study seeds treated with both electric and magnetic field of 125 mT + 75 mA for 3minutes and 60 seconds showed significant increase in the seed yield per plot and increase in the seed yield per hectare percentage increase from control. In this study, seeds treated with magnetic field at 50 mT by placing in between the poles of electromagnet field for 3 minutes significant improved field emergence percentage as compared to control.

In laboratory conditions seeds after treated by magnetic field, electric current and electromagnetic field showed significant differences among germination of seeds when seeds placed in between paper method for germination. Higher germination was noticed in seeds treated with magnetic field at T1 (50 mT for 3 min) percentage increase as

compared to control. Higher vigor index-I, vigor index-II was noticed under the seeds treated with combination of both electric current and magnetic field of 50 mT + 75 mA for 3 minutes +30 seconds.

Magnetic fields are only one of several factors that effect on plant growth and development. Results obtained from the present study showed that magnetic field significantly improved germination percent as well as field emergence both in laboratory and field conditions.

The increase in germination by seeds treated with magnetic field could be explained by better availability and absorption of nutrients. Pulse magnetic fields have been found to promote germination and improve early growth characters of cotton seedlings. The productivity of tomato plants using magnetic stimulated seeds or irrigation with magnetized water showed better result in stimulated seeds, compared to control in terms of germination, fresh weight and plant growth. (Efthimiadou *et al.*, 2014).

Electromagnetic treatment

Conclusion

From the study it is concluded that the buckwheat seeds treated with various magnetic and electric treatments showed significant variation among different treatments T10 (75 mT + 100 mA for 3min + 30 sec) treatment showed better in field emergence percentage as compared to control, minimum days to first flowering was found in T3 , maximum seed yield per plot was found in T12, maximum seed yield per hectare was found in T12 (Magnetic field + Electric current @ 125 mT + 75 mA for 3 min + 60 sec) and maximum harvest index was recorded in T8 (Electric Current @ 125 mA for 60 sec).

It is concluded that the buckwheat seedlings treated with various magnetic and electric treatments showed significant variation, among various treatments T1 (Magnetic Field @ 50 mT for 3 min) showed better in terms of germination percentage increase as compared to control (96.25%). High vigor index II was recorded in T9 (14.15) percentage increase as compared to control (Magnetic Field + Electric Current @ 50 mT + 75 mA for 3 min + 30 sec).

Both the electric current and magnetic field treatment of the seeds were likely played important roles in production of food and increase in production.

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Competing interests

Authors have no competing interests.

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