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EFFECT OF SEED PRIMING AND DIRECT SOIL APPLICATION OF AGRO-ORGANIC WASTE FORMULATIONS ON GROWTH OF *TRITICUM AESTIVUM* AND *BRASSICA NIGRA*

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ABSTRACT

The use of organic formulations is gaining attention in Indian agricultural system and has a potential to fulfill the food demand. The aim of this study was to investigate the effect of seed priming and direct application of agro-organic formulations on the growth of *Triticum aestivum* L. and *Brassica nigra* in pot studies. Four different agro-organic formulations viz. traditional and modified Panchagavya and Jeevamrit at different concentrations (1:50 to 1:200) were used for seed priming and direct soil application. Seed primed with respective organic formulations were observed for germination pattern for 8 days. For direct application method, sterile soil was used and growth parameters were studied for 10 and 8 days in wheat and mustard respectively. All the treatments were kept under controlled condition of temperature of 24±2°C and 1000 lux throughout study. Seed priming showed significantly higher germination percentage and seed vigour index (SVI) in wheat (98% and 2216) when primed with modified formulation, while in mustard (64% and 684) when primed with traditional formulation as compared to control (autoclaved distilled water). Direct soil application showed significant difference in the germination percentage (100%), SVI (1205 and 1443), shoot length (10.3cm and 10.63cm), root length (5.7cm and 7.53cm) and seedling length (12.06cm and 14.38cm) of wheat and mustard respectively on comparing with control when subjected to treatment with traditional formulation for wheat and modified formulation for mustard. Further studies of agro-organic formulations in field will enhance our knowledge about the mechanism to increase the crop yield.

Keywords: Panchagavya, Jeevamrit, *Triticum aestivum*, *Brassica nigra*, Growth parameters.

1. INTRODUCTION

Wheat (*Triticum aestivum*) and Mustard (*Brassica nigra*) are major rabi crops grown in India. The productivity of these crops has enhanced considerably during the last four decades in the country. The credits of inter-cropping of wheat and mustard has led to increase in yield [1]. On the other hand, misuse of chemical fertilizers, pesticides and lack of crop rotation have impeded the yield of these crops and affected the agricultural income [2]. The use of organic fertilizers as an eco-friendly alternative for sustainable agriculture have been appealing many scientific communities, farmers and consumers. The organic cereals are reported to have better amino acid scores as compared to conventional cereals [3]. Organic manures contain natural minerals necessary for the crops and also helps to improve the soil texture and performance. Incorporation of these soil amending agents would substitute the rhizosphere environment by impacting positively the porosity, aeration, temperature, water holding capacity and microflora of soil [4]. India being prosperous in organic resources, can utilize them to acquire better physical, chemical, biological properties of soil and crop yield.

The popularly used organic supplements like Panchagavya and Jeevamrit are reported to have efficient plant growth stimulants [5]. Panchagavya is a combination of source ingredients obtained from cow. It can be used in various ways like seed treatment, soil application and foliar spray [6]. It also has a significant role in crop production, as biopesticide and crop management [7]. Jeevamrit is an excellent source of micronutrients required by plant and contributes abundantly to the beneficial microbial load in the soil. These liquid manures are reported to enhance the yield of many crops and repress the growth of plant

pathogens [5]. Cow dung and urine-based manures are dynamic, cost effective as well as capable to restore micronutrients and fertility of soil. However, there is lack of scientific data providing insights on use of traditional liquid manures like Panchagavya and Jeevamrit. Thus, an integrated perspective is necessary for promoting the valuable elements and employment of these liquid manures on large scale for improving soil quality and enhancing crop productivity.

These liquid manures are applied in different ways like seed priming, soil application, and seedling dip depending on the target crop under study. Seed germination and seedling growth are important in agriculture. Seed priming is a pre-sowing technique used for enhancing efficiency of germination and it is being reported to partially hydrate the seeds to initiate germination-related metabolic process [8]. It protects the seeds from damage and helps increase the yield of crops [9]. The liquid manures can be applied directly to the soil by mixing it with the irrigation water in appropriate concentration. The appropriate way could be, to mix the liquid manures in water and stirred for one hour and sprayed on field directly before sowing or transplantation [10]. It has been reported that application of liquid manures in natural farming systems has enhanced the crop yield and quality as well as better net returns [11]. With these understanding, the current study is an attempt to envisage the evaluation of application method viz. seed priming and direct application of agro-organic waste formulations on growth of wheat and mustard.

2. MATERIAL AND METHODS

Experiments were conducted in the laboratories of Department of Biotechnology, HVPS's Ramniranjan Jhunjhunwala College of Arts, Science and Commerce (Autonomous), Mumbai. The experiments were carried out in two levels by carrying out seed priming and direct application of agro-organic formulations on growth parameters of *Triticum aestivum* and *Brassica nigra*.

2.1. Preparation of organic formulations

In total, four different organic formulations were used. Of these, Panchagavya (PVG) and Jeevamrit (JVM) was traditionally prepared as described by Naresh and co-workers [12]; while other two were modified formulation of Panchagavya (MPVG) and Jeevamrit (MJVM) prepared by addition of agro-organic waste.

2.2. Evaluation of plant growth promotion

All the four agro-organic formulations were evaluated for its plant growth promotion ability on wheat and mustard using seed priming and direct application methods under *in vivo* conditions. The wheat seeds were obtained from private vendor from Mumbai, whereas mustard seeds were obtained from Namdeo Umaji Agritech (India) Pvt. Ltd during the entire period of study. Healthy seeds of wheat (*T. aestivum*) and mustard (*B. nigra*) were taken under consideration and surface sterilized as described by Singh and co-workers [13,14].

2.2.1. Seed priming

Seeds were soaked with four different concentrations (1:50 to 1:200 dilutions made with distilled water) of the respective organic formulations along with control (autoclaved distilled water) for a duration of 20 minutes and air dried overnight at room temperature. Further, the primed seeds were transferred to sterile glass jars with moist filter paper and were incubated at temperature of 24±2°C. All the treatments were carried out in three replicates and were frequently moistened with autoclaved water. Germination behavior was observed up to 8 days of incubation for both wheat and mustard.

2.2.2. Direct application

Surface sterilized seeds were sown in sterilized soil at a depth of 2cm and 0.5cm for wheat and mustard respectively in a plastic seedling tray. Diluted preparation of the respective organic formulations as prepared for seed priming were applied to the soil (2ml/treatment). All the treatments were carried out in three replicates along with a control (autoclaved distilled water). The study was carried out in controlled environment maintaining temperature of 24±2°C and light of 1000 lux until the completion of study. Germination behavior was observed up to 10 and 8 days for wheat and mustard respectively.

For all the organic formulations, data for germination percentage, root length, shoot length, seedling length and seed vigour index (SVI) were recorded for both seed priming and direct application methods. The treatment details used for seed priming and direct application of agro-organic formulations is as described in Table 1.

2.3. Evaluation of growth parameters

2.3.1. Seed germination (%)

Germination test was conducted using triplicates in all

the respective treatments. The number of normal seedlings was counted at the end of respective incubation time and germination percentage was calculated and expressed in percentage.

Seed germination (%) = Number of normal seedlings/ Total number of seeds × 100

2.3.2. Root length (cm)

The root length was measured from the tip of primary root to the hypocotyl and mean root length was expressed in centimeters.

2.3.3. Shoot length (cm)

The shoot length was measured from the top of leaf to the hypocotyl and mean shoot length was expressed in centimeters.

2.3.4. Seedling length

Seedling length (cm) was determined by adding shoot and root length.

2.3.5. Seedling vigour index

SVI was calculated as follows:

SVI = Germination (%) × Seedling length (cm)

Growth parameters were evaluated as described by Roshani and coworkers [15].

Table 1: Organic formulation and the dilution used for seed priming and direct application methods

Treatment (T)	Concentration of organic formulation
T1	Autoclaved distilled water (Control)
T2	1:50 dilution of PVG
T3	1:100 dilution of PVG
T4	1:150 dilution of PVG
T5	1:200 dilution of PVG
T6	1:50 dilution of JVM
T7	1:100 dilution of JVM
T8	1:150 dilution of JVM
T9	1:200 dilution of JVM
T10	1:50 dilution of MPVG
T11	1:100 dilution of MPVG
T12	1:150 dilution of MPVG
T13	1:200 dilution of MPVG
T14	1:50 dilution of MJVM
T15	1:100 dilution of MJVM
T16	1:150 dilution of MJVM
T17	1:200 dilution of MJVM

PVG- Panchagavya, JVM- Jeevamrit, MPVG-Modified Panchagavya, MJVM- Modified Jeevamrit

2.4. Statistical analysis

The results of the growth parameters are the means of three replicates. Variability in the recorded data was determined by carrying out statistical analysis by performing ANNOVA using SPSS Statistics 28.0. Means of different treatments were compared at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. Seed priming

Wheat and mustard seeds were primed with different concentrations (T2-T17, Table 1) of four different agro-organic formulations, and were evaluated for their effect on growth parameters. It was observed that various treatments showed a significantly different effect on growth parameters (Germination percentage, root length, shoot length, seedling length and seed vigour index) possibly due to the presence of beneficial microbial population, phytohormones, growth factors present in the prepared organic formulations [5].

Wheat seeds showed highest germination percentage in T17 (98%) as compared to control (80%) (Fig. 1); while for mustard in T4 dilution (64%) gave higher germination percentage as compared to control (35%). Modified formulation (MJVM) has a better effect on germination of wheat as compared to mustard; where traditional organic formulation showed better germination after 8 days of incubation.

The SVI expresses the ability of seeds to survive under influence of stress. The SVI was observed to be significantly higher in T12 (2216 & 684) as compared with control (1514 & 293) for both wheat and mustard respectively (Fig.2). The improved effect of MPVG on SVI could be attributed to activation of certain enzymes leading to increased metabolic activity. The augmented germination and SVI may be due to reactivation of metabolic processes of seeds causing biosynthesis of plant hormones like auxin, ultimately triggering growth of embryo [16, 17]. Previous studies by Iseri and co-workers [18] reported that seed priming can lead to mobilization of storage protein which further primes germination rate and seed potential.

The shoot length, root length and seedling length for wheat and mustard were measured post 8 days of seed priming. The shoot length of wheat was significantly higher in T4 (13.10cm) as compared to control (10.91cm); while the root and seedling length was higher in T3 (11.23cm and 24cm) as compared to control (8cm and 18.50cm) respectively. The traditional formulation (PVG) gave better shoot length

at 1:150 dilution (T4), while 1:100 dilution (T3) gave improved root and seedling length (Table 2).

For mustard, the shoot length was significantly higher in T12 (8cm) as compared to control (5.03cm); while the root and seedling length were higher in T11 (5.10cm and 12.15cm) as compared to control (3.30cm and 8.38cm) respectively. In this study among the four formulations, the modified formulation (MPVG) showed better shoot length at 1:150 dilution (T12), while 1:100 dilution (T11) gave better root and seedling length (Table 2).

The liquid manures used for seed priming have been reported to be rich in growth promoters [5, 19]. In our study, these liquid formulations showed a positive impact on the development of shoot, root and seedling length. The beneficial effects of liquid manures on seed priming may have improved germination, initial seedling establishment, SVI and overall growth parameters. Such enhancement of root/shoot length, SVI etc is also reported in many crops like radish, maize, soyabean, wheat [20- 23]. The plant growth augmentation may be due to the beneficial microbes like *Rhizobium*, *Azotobacter*, phosphate solubilizing bacteria and other plant growth promoting microbes. Although our study did not attempt to analyze the effect of time on seed priming using the liquid formulations which can be an important parameter for studying the seed germination and overall plant health in the field.

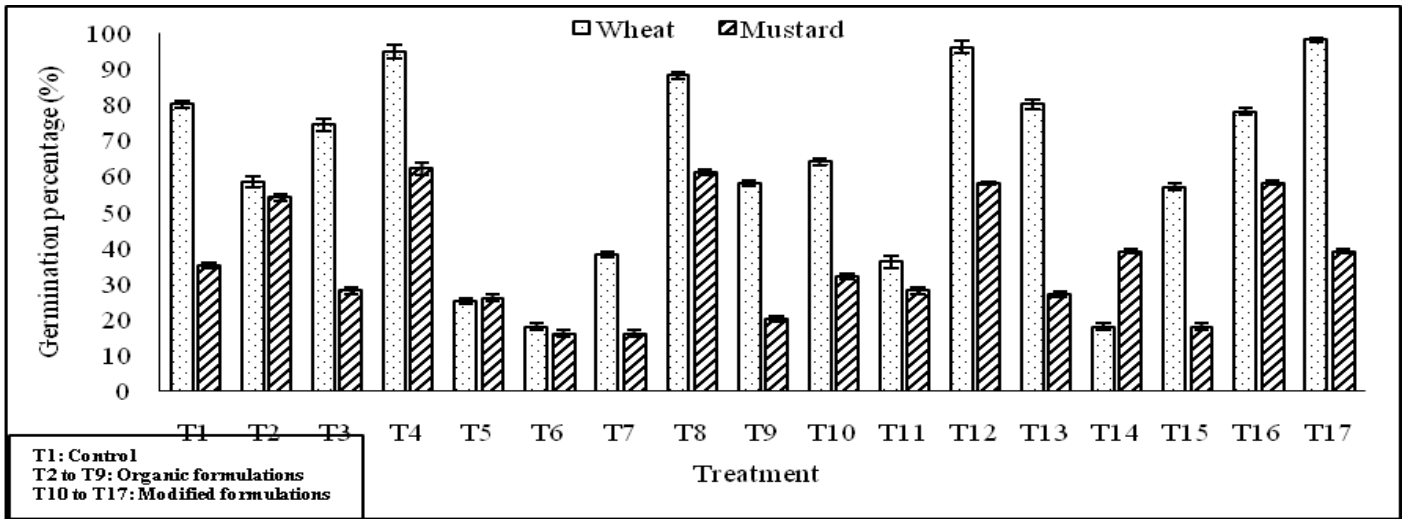

Fig. 1: Effect of seed priming with different concentration of agro-organic formulations on germination percentage of *Triticum aestivum* and *Brassica nigra*

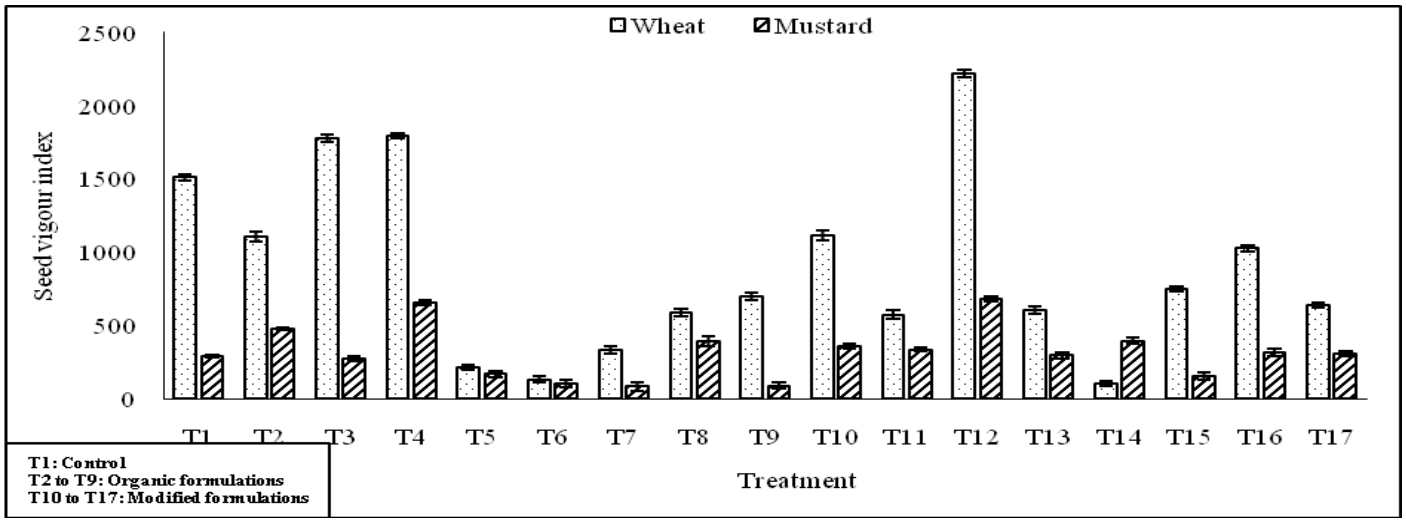

Fig. 2: Effect of seed priming with different concentration of agro-organic formulations on SVI of *Triticum aestivum* and *Brassica nigra*

Table 2: Effect of seed priming with different concentration of agro-organic formulations on the growth parameters of *Triticum aestivum* and *Brassica nigra*

Treatment (T)	Wheat			Mustard		
	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Shoot length (cm)	Root length (cm)	Seedling length (cm)
T1	10.9±0.05 *	8±0.50*	18.50±0.50*	5.03±0.25*	3.30±0.30	8.38±0.18*
T2	12.56±0.40	6.56±0.51*	19± 0.56	5.73± 0.38	3.40±0.20	8.80±0.20*
T3	12.5±0.46	**11.23±0.25***	**24± 0.20***	5.86±0.15*	3.83±0.21	9.8±0.20*
T4	**13.10±0.28***	5.80±0.26*	18.98±0.28	6.26± 0.38	4.05±0.20*	10.66±0.20*
T5	6.23±0.25*	2.40±0.36*	8.83±0.21*	3.30±0.36*	3.06±0.30	6.70±0.26*
T6	4.43±0.40	2.80±0.26	7.33±0.30*	3.23±0.32	2.13±0.21*	5.53±0.21
T7	5.10±0.20*	3.26±0.38	8.80±0.26*	2.40±0.40	3.26±0.32	5.70±0.20
T8	4.30±0.20	2.56±0.51	6.73±0.21*	3.36±0.40	3.03±0.15*	6.50±0.20*
T9	7.36±0.15*	4.93±0.30*	12± 0.20*	1.96±0.25*	2.66±0.25	4.53±0.21*
T10	10.46±0.25*	7.10±0.36*	17.55±0.33*	7.26±0.25*	4.06±0.21	11.31±0.22
T11	8.56±0.21*	7.40±0.36	15.93±0.25*	6.80±0.20*	**5.10±0.20***	**12.15±0.23***
T12	12.66±0.21*	10.56±0.49*	23.81±0.17*	**8±0.36***	3.83±0.21	11.69±0.19*
T13	3.56±0.30*	4.53±0.47*	7.65±0.15*	6.40±0.15*	4.65±0.35*	11.04±0.17
T14	2.73±0.25*	2.93±0.30	5.78±0.17*	4.67±0.20*	4.50±0.36*	10.25±0.23*
T15	8.70±0.26	4.13±0.32	13±0.11	5.66±0.15*	3.08±0.17	8.72±0.20*
T16	9.10±0.20	4.15±0.22	13.31±0.28	3.50±0.20*	1.78±0.17*	5.60±0.20*
T17	3.43±0.40*	3.30±0.26	6.7±0.26*	2.63±0.21*	5.25±0.23*	7.95±0.18*

(T1= Control, T2 to T9= Organic formulations, T10 to T17= Modified formulations)

** Significant at 5% probability level*

3.2. Direct application

Direct application of prepared agro-organic formulations at different concentration (Table 1) was carried out in seedling tray filled with sterilized soil. Fig.3 represents the highest germination percentage observed in T5 and T7 (100%) as compared to control (55%) for wheat; while for mustard all the four agro-organic formulations in T2, T6, T10, T16 showed 100% germination in comparison to control (88%). In wheat, the SVI (Fig.4) was observed to be three-fold higher in T5 (1205) as compared to control (389); while for mustard like seed priming, a fourfold higher SVI was observed in T11 (1443) as compared to control (384). Traditionally prepared PVG (1:200) and MPVG (1:100) are showing an improved SVI for both wheat and mustard.

The organic liquid formulations are reported to improve the soil fertility [24]. Greater availability of nutrients in these preparations are supporting the growth. Apart from supplying major nutrients it also supplies secondary and micro nutrients which may be leading to increased germination and SVI [25].

All the three growth parameters were also studied after direct application of agro-organic formulations on wheat and mustard. Table 3 reflects the data for wheat and mustard after 10 and 8 days of application of these formulations. For wheat, the shoot length was significantly higher in T3 (10.23cm) as compared to control (4.43cm); while root length was higher in T2 (5.7cm) as compared to control (2.53cm). The highest seedling length was observed in T9 (12.06cm) as compared to control (7.03cm).

For mustard, the root length was three-fold higher in T2 (7.53cm) as compared to control (1.96cm); while the shoot and seedling length was observed to be highest in T11 (10.63cm and 14.38cm) as compared to control (2.30cm and 4.39cm) after application (Table 3).

The liquid organic formulations like Panchagavya and Jeevamrut are fermented products used as plant growth enhancers. Devakumar and co-workers [26] and Sreenivasa co-workers [27] have reported that there are many beneficial microorganisms present in organic liquid formulations. These beneficial microorganisms help in mineralization of soil and nutrients and making it available to plants when applied to soil [28]. The benefit of direct application method of these liquid formulations is that they diffuse readily and are rapidly taken up by the plants when used in irrigation.

Panchagavya and Jeevamrit are reported to have beneficial microorganisms like nitrogen fixers, phosphate solubilizers [26, 29]. Gohil and co-workers [30] have isolated and screened several beneficial microbes for plant growth promoting properties. To

corroborate the type and amount of beneficial microorganisms present in the traditional and modified agro-organic waste formulations, similar study was initiated by isolating and screening of plant growth promoting bacteria. Nitrogen fixers and phosphate solubilizers were isolated from above agro-organic formulations (Unpublished work). The prepared formulations (traditional and modified agro-organic formulations) at varying concentrations showed improved growth parameters as compared to control, when applied either by seed priming or by directly in soil indicating its potential application in enhancing plant growth. Further the characterized organisms can be studied as monoculture or as a consortium to study the effect of these PGP microbes on different plants in different types of soil and in environmental stress.

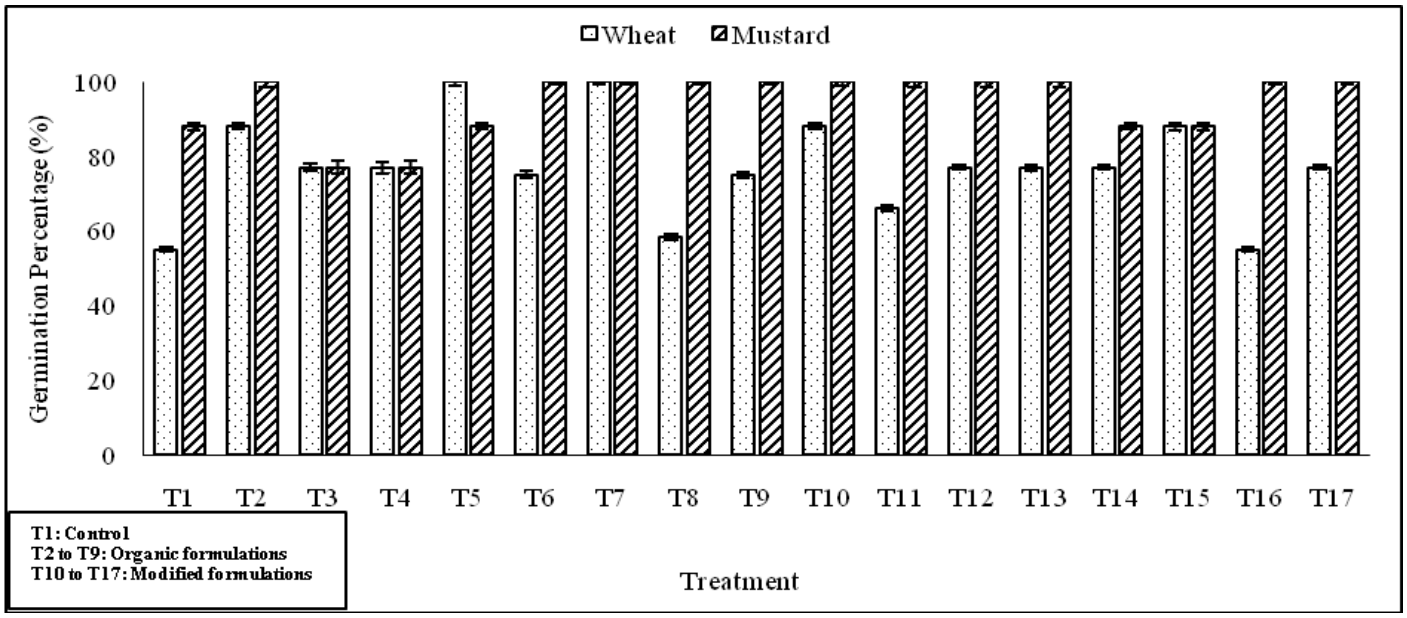

Fig. 3: Effect of direct application with different concentration of agro-organic formulations on germination percentage of *Triticum aestivum* and *Brassica nigra*

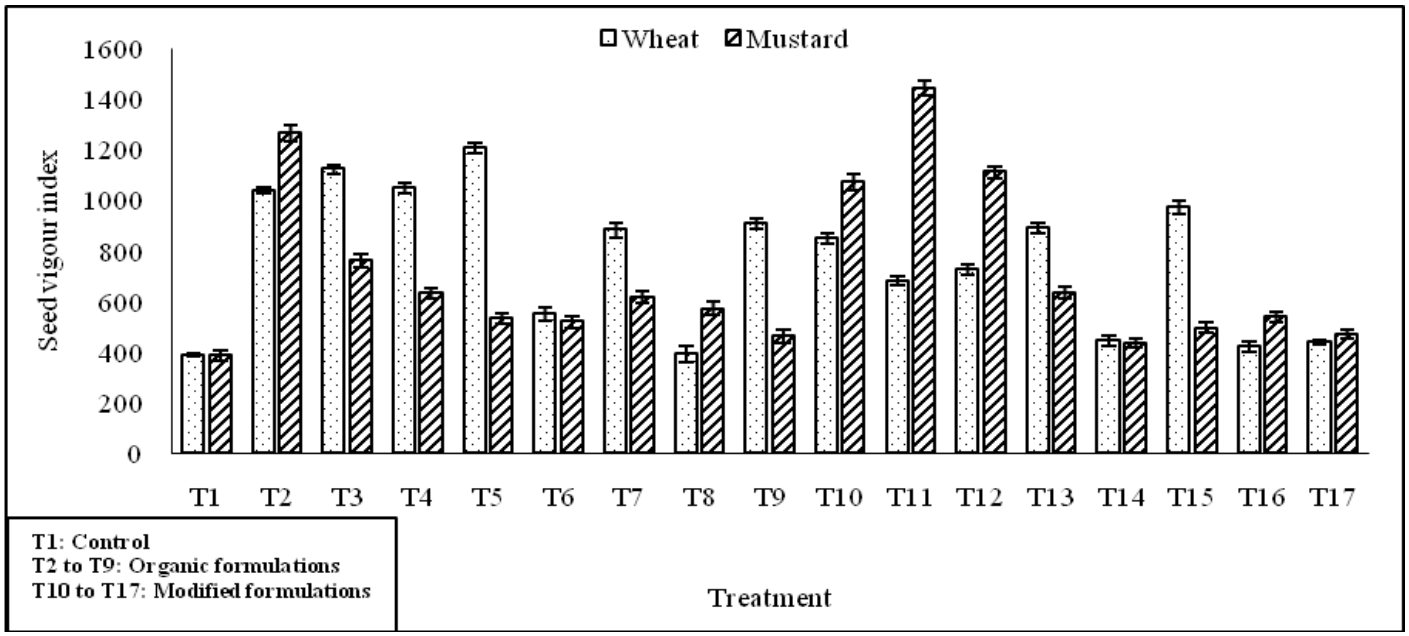

Fig. 4: Effect of direct application with different concentration of agro-organic formulations on SVI of *Triticum aestivum* and *Brassica nigra*

Table 3: Effect of direct soil application of different concentration of agro-organic formulations on the growth parameters of *Triticum aestivum* and *Brassica nigra*

Treatment (T)	Wheat			Mustard		
	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Shoot length (cm)	Root length (cm)	Seedling length (cm)
T1	4.43±0.38*	2.53±0.30*	7.03±0.15*	2.30±0.30*	1.96±0.15*	4.39±0.14*
T2	6.03±0.15*	**5.7±0.20***	11.75±0.15*	5.20±0.30*	**7.53±0.21***	12.56±0.16*
T3	**10.23±0.30***	4.46±0.25	14.69±0.19*	3.26±0.25	6.63±0.25*	9.82±0.15*
T4	9.43±0.15*	4.23±0.21*	13.70±0.20*	2.66±0.25*	5.66±0.25*	8.28±0.15*
T5	7.66±0.21*	4.8±0.26	12.16±0.26*	3.30±0.26	2.83±0.21*	6.06±0.13*
T6	4.56±0.30	2.8±0.20*	7.43±0.22*	3.03±0.15*	2.26±0.25*	5.16±0.17*
T7	5.1±0.26	3.53±0.30	8.80±0.15*	3.70±0.20	2.60±0.20	6.57±0.25*
T8	4.3±0.20	2.43±0.30*	6.7±0.18*	3.23±0.25	2.40±0.18	5.80±0.21*
T9	7.21±0.20	4.70±0.20*	**12.06±0.14***	2.66±0.25	2.20±0.30*	4.59±0.26*
T10	8.16±0.25	1.73±0.21*	9.70±0.18	8.23±0.20*	2.60±0.20*	10.74±0.10*
T11	8.13±0.15	2.26±0.25	10.29±0.16*	**10.63±0.25***	3.80±0.26	**14.38±0.16***
T12	7.06±0.21*	2.53±0.25	9.43±0.16	7.71±0.30*	3.53±0.26*	11.24±0.29*
T13	8.23±0.25*	3.16±0.25*	11.41±0.21*	3.56±0.30*	2.86±0.20*	6.46±0.31*
T14	2.97±0.14*	2.75±0.23*	5.68±0.15	3.07±0.25*	1.96±0.15	5.07±0.16*
T15	6.73±0.21*	4.16±0.25*	11.16±0.19*	3.00±0.28	2.60±0.30	5.70±0.23
T16	4.53±0.20*	3.16±0.25*	7.59±0.17*	2.85±0.13*	2.56±0.21*	5.50±0.24
T17	2.43±0.20*	3.33 0.21	5.64±0.19*	2.53±0.21	2.06±0.25*	4.72±0.14*

(T1= Control, T2 to T9= Organic formulations, T10 to T17= Modified formulations)

** Significant at 5% probability level*

4. CONCLUSION

This study attempts to evaluate and establish the potential of agro-organic formulations as growth enhancers in *Triticum aestivum* and *Brassica nigra* using seed priming and direct application methods. Results of the present findings demonstrates the use of both the traditional and modified formulations on analyzing the growth parameters of wheat and mustard. Seed priming with modified formulation have significantly improved the germination percentage and SVI of wheat as compared to control; while traditional formulation was found efficient in improving germination percentage and SVI in mustard indicating the organic formulations may not interact in the same way for all the plants. Further, the present study also demonstrated that direct application of traditional and modified formulation was better for seed priming as it increased the germination and SVI in wheat and mustard respectively. Similar trend was observed for other growth parameters (shoot, root and seedling length) for wheat and mustard. Thus, we can conclude that seed priming is enhancing germination; while direct application method is improving all the growth parameters in wheat and mustard. However, since the liquid formulations are highly dynamic, substantial studies in field using these four formulations will help us establish the amount and type of organic formulations to be applied to different plant types.

5. ACKNOWLEDGMENT

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Conflict of interest

All the authors declare that there are no conflicts of interest for the associated research data.

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