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RESEARCH ARTICLE

Role of Gibberellic Acid and Vermiwash on Seed Germination and Seedling Growth of Wheat and Mustard

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ABSTRACT

In current arena, sustainable agriculture has become important due to degradation and soil pollution. Rapid utilization of organic as well as bio-fertilizers is an important practice in the field of agriculture. Vermiwash is a liquid bio fertilizer that causes enhancement in growth of many plants. A laboratory experiment was conducted at Department of Agronomy, University of Agriculture, Faisalabad, Pakistan using factorial experimental design based on completely randomized design with three replications to study the role of vermiwash and gibberellic acid on seed germination and seedling growth of wheat and mustard. Seed germination characters and seedling growth parameters were analyzed. The treatments were: Control, Gibberellic acid (GA) and vermiwash application at 10% and 20% concentrations. For comparison of treatment's means LSD test at 5% level of significance was used. Seedling properties and germination characters were significantly affected by GA and vermiwash application and it produced the highest values of germination character as compared to control. Maximum germination index, final germination percentage (100%) and minimum mean germination time were observed in 50 ppm GA3 treatment followed by alfalfa vermiwash treatments in both crops. While vermiwash significantly ($P<0.05$) affected the root fresh weight, shoot fresh weight, root dry weight and shoot dry weight. Thus, for organic farming vermiwash can be successfully used which can save our environment from synthetic fertilizers.

INTRODUCTION

Agriculture is among the most important sectors in the economy of the country where synthetic fertilizers play a key role in enhancing the crop yield. Now a day, use of the chemical fertilizers for agricultural growth leads to an unachievable burden on the environment. Organic farming is an environmental friendly approach for sustainable agriculture and it is one of the relatively inexpensive and convenient methods. Now a day, the introduction of synthetic fertilizers is bringing up in agriculture day by day which is ultimately destroying the soil fertility. Organically produced fertilizers may be employed as an alternating resource to control the harmful effect of these synthetic fertilizers. Vermicompost and vermiwash improve the physiochemical properties of soil (Tharmaraj et al., 2010). During vermicompost preparation, liquid manure is obtained which is called vermiwash. It contains phytohormones like auxins and cytokinins. According to Zambare et al. (2008) Vermiwash contains some bacteria which are capable to fix nitrogen to rhizosphere such *Azotobacter* sp., *Rhizobium* sp. and *Agrobacterium* sp. Moreover, these also contain an enzyme cocktail of amylases, phosphatses, proteases and urease.

Vermicompost has also engrossed the soluble plant nutrients along with organic acids and some mucus mixed by the microbes and earthworm. It has shown its importance when used on cow pea for sustained production. Edwards and Bohlen (1996) reported an increase of 7.3% in radish yield with the application of vermicompost. The current trial was conducted to evaluate the effect of vermiwash on the seed germination of wheat and mustard.

Several organic fertilizers have produced significant results in regard to crop yields and quality (Fathima and Sekar, 2014). Recent researchers have cited the fruitful use of fertilizers when applied as foliar spray. Liquid fertilizers are gaining more importance due to fewer chances of fixation in soil. Vermiwash is an alternate liquid fertilizer that is of great importance in organic agriculture as it is produced naturally and does not contain any synthetic of the harmful element. Additionally, it has the ability to supply plant nutrients more efficiently and rapidly. Vermiwash has growth promoting effects on plants. *Hibiscus sabdariffa* has produced the best fiber contents with the application of growth regulators (Fathima and Balasubramanian, 2006). Vermiwash has been used effectively as bio fertilizer in organic farming (Lalitha et al. (2000); Zambare et al. (2008).

Plant hormones help in increasing plant stress tolerance against abiotic factors and to cope with the unfavorable environment (Srivastava and Srivastava, 2007). Gibberellic acid serves as a vital plant hormone and acts as a regulating agent in germination and growth by regulation of signal pathways (Cavusoglu and Sulusoglu, 2015). Literature shows much beneficial aspects of GA_3 in increasing plant growth, leaf broadness, stem elongation and in the development of flowers in many plants (Khan and Chaudhry, 2006).

Gibberellic Acid is amongst the most significant growth regulators playing a critical role in breakage of seed dormancy, improvement in germination, hypocotyls growth, intermodal length, cell division and escalated size of leaves (Abido et al., 2019).

These are necessarily used for seed dormancy breakage and may significantly contribute in improving germination of seed in many plant species by activating the embryonic growth, enhancing reserves translocation and by weakening the endospermic layer of the seed. Seed treatment with GA_3 has proved to be most suitable for germination and other plant parameters in *Capparis spinosa* (Heydariyan et al., 2014). *Trigonella foenum-graecum* (Farahmandfar et al., 2013), *Trifolium repens* L., *Beta vulgaris* (Dotto and Silva, 2017), *Zea mays* L. (Ghodrat and Rousta, 2012) and *Medicago sativa* (Younesi and Moradi, 2014). Considering the above discussion, the objectives for the current trial were to discover the effects of GA_3 and vermiwash on germination of wheat and mustard.

Mustard (*Brassica Campestris*) is the main oil crop. The oil content varies from 38 to 48% depending on variety and soil condition. The oil contains 7% moisture, 36% fats, and 25% nitrogenous substances.

Wheat (*Triticum aestivum*) has been classified under cereals category and is served as a staple food for a diverse number of countries in the world. It holds a considerable role in the GDP of Pakistan. Wheat is considering the indispensable source for carbohydrates and various necessary nutrients and fiber as well (Shewry and Hey, 2015). According to FAO (2018) total area under wheat cultivation escalated throughout the globe with a record of 220.10 mha in 2016 and the total global production was 749.46 million tons.

Now-a-day, vermiwash is widely used in organic farming. Seed germination is the first and very important event in life of plants, hence in the present investigation attempts were made to study the effect of Gibberellic acid and Vermiwash on wheat and mustard during seed germination.

MATERIALS AND METHODS

Seeds for the experiment were collected from Ayub Agriculture Research Institute. The experimental crops were *Triticum aestivum* and *Brassica campestris*. A laboratory experiment was conducted at Department of Agronomy, University of Agriculture, Faisalabad, during the period of December, 2019 to January, 2020 to study the performance of wheat and mustard seeds to germination under the application of vermiwash and gibberellic acid.

Preparation of gibberellic acid

Stock solution of Gibberellic acid for the experiment was prepared as 50 mg L^{-1} or 50 ppm. For stock solution 50 mg of GA was liquefied in 1000 ml of distilled water.

Preparation of vermiwash solution

By using alfalfa vermiwash and distilled water (V/V), two dilutions of 10% (1:10) and 20% (1:5) vermiwash were prepared. Where 1:10 for 10% vermiwash consists of 10 ml vermiwash diluted 10 times and 1:5 for 20% vermiwash consist of 10 ml vermiwash diluted 5 times respectively.

Treatments and experimental design

All the proposed treatments were used in accordance to a factorial experiment based on complete randomized design (CRD) with three replicates. Factor A: contained two crops; wheat and mustard. Factor B: includes 4 treatments. Seeds were sterilized using 0.05% $HgCl_2$ for a minute and then rinsed carefully with tap water followed by distilled water. Seeds were then arranged in Petri plates (10 seeds per plate) containing a filter paper. Distilled water (control), 50ppm gibberellic acid (Treatment 1), 10% vermiwash (Treatment 2) and 20% vermiwash (Treatment 3) were poured in respective Petri plates of both crops. Total seeds germinated were recorded on daily basis. Different germination parameters like Mean Germination Time (MGT), Germination Index (GI), Final Germination Percentage (FGP), Shoot Length (SL), Root Length (RL), Shoot Fresh Weight (SFW), Root Fresh Weight (RFW), Shoot Dry Weight (SDW) and Root Dry Weight (RDW) were observed during the research.

Following formula reported by Al-Mudaris (1998) was used for the calculation of germination parameters.

MGT= $\Sigma Nx/\Sigma N$ (N is total No. of seeds germinated on day X).

GI (Germination index)=G1/1+G2/2+....+Gi/I (G1 is the percentage of germination at 1st day, G2 is the percentage of germination at 2nd day, and so on).

Final germination % (FG %) = No. of seeds germinated at last day of trial/ total No. of seeds in each Petri dish multiply by 100.

Statistical analysis

Completely randomized design (CRD) was used in experiment. Three replications were made for each of four treatments. Experiment was done for two different crops. Statistical analysis of recorded data is done by using ANOVA techniques. For comparison of treatment's means LSD test at 5% level of significance was used (Steel et al., 1997).

RESULTS

Different morphological parameters like root length, shoot length, root fresh weight and shoot fresh weight were studied on 12 DAS (days after sowing) using routine method. The experiment revealed that both vermiwash and gibberellic acid improves germination in wheat and Mustard. Both of the crops showed beneficial results with use of vermiwash and therefore it is important to evaluate the response the different concentrations of vermiwash for both crops separately. Minimum Mean germination time was coupled with maximum germination index and final germination percentage was observed under GA_3 application followed by 20% and 10% vermiwash solution as compared to control.

Mean germination time (MGT)

Seed took minimum mean germination time under GA_3 treatment. The order of seeds germination to different treatments was GA_3 > 20% vermiwash > 10% vermiwash > control. According to Graph 1 MGT showed the highest values at control (6.313 in wheat and 6.47 in mustard) and slightly decreased at 50 ppm GA application (6.0733 and 6.14 in wheat and mustard respectively).

Germination index (GI)

Germination index was influenced significantly by all treatments. The highest GI was recorded at GA application (12.733 in wheat and 12.06 in mustard) while it shows the lowest value in control (8.34 in wheat and 7.16 in mustard) (Graph 2).

Final germination %age

Germination %age was significantly influenced by all treatments. Highest germination %age was recorded at GA application (100% in both crops) while it shows the lowest value in control (83.33% in wheat and 80% in mustard) (Graph 3).

Root length

There was a considerable significant variation in root length between the control and treated seeds. Treated seeds showed a considerable elongation of roots when compared to control seeds. Maximum shoot length was observed with Gibberellic acid treatments (8.666 cm in wheat and 6.766 cm in mustard) followed by 20% vermiwash treatment (7.9 cm and 4.5 cm in wheat and mustard respectively), 10% vermiwash treatment (7.333 cm in wheat and 3.9 cm in mustard) than in control (6.466 cm in wheat and 2.433 cm in mustard) seeds (Graph 4).

Shoot length

A significant variation in shoot elongation was noticed between the control and treated seeds. A noticeable increase was recorded in seeds treated with GA in relation to controlled seeds. Maximum shoot length was observed with Gibberellic acid treatments (16.733 cm in wheat and 9.633 cm in mustard) followed by 20% vermiwash treatment (15.567 cm and 8.267 cm in wheat and mustard respectively), 10% vermiwash treatment (14.867 cm in wheat and 8.167 cm in mustard) than in control (13.467 cm in wheat and 4.467 cm in mustard) seeds (Graph 5).

Root fresh weight

The data observed showed that root fresh weight was boosted in all the treatments except control. The maximum RFW was recorded in vermiwash 20% (156 mg and 30.67 mg in wheat and mustard respectively), vermiwash 10% (136 mg and 25 mg in wheat and mustard respectively), GA (119 mg and 19.67 mg in wheat and mustard respectively). The minimum RFW was observed in control (90 mg in wheat and 15.33 mg in mustard) seedlings (Graph 6).

Shoot fresh weight

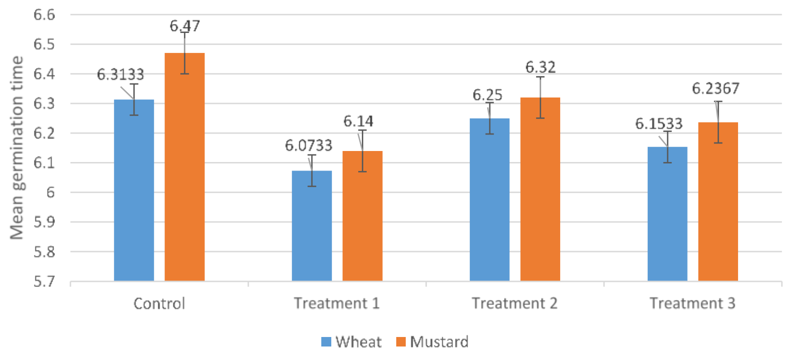
Recorded data indicated that shoot fresh weight was escalated in all treated seeds when compared to control seeds. The maximum RFW was recorded in vermiwash 20% (353.33 mg and 135 mg in wheat and mustard respectively), vermiwash 10% (300 mg and 76.33 mg in wheat and mustard respectively), GA (270 mg and 51.33 mg in wheat and mustard respectively). The minimum RFW was observed in control (240 mg in wheat and 42.67 mg in mustard) seedlings (Graph 7).

Root dry weight

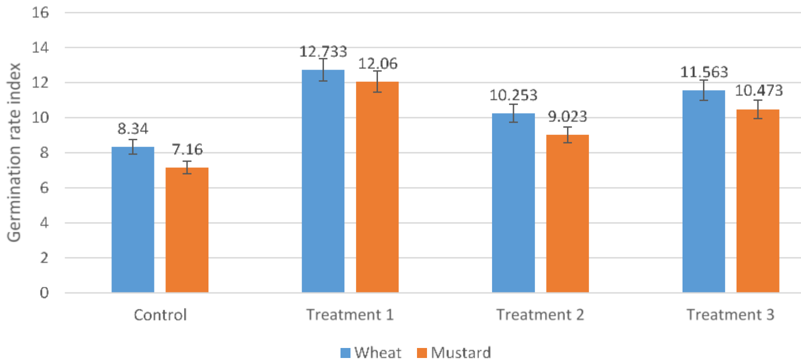
Collected data showed that root dry weight was improved in all treatments except control. The maximum RFW was recorded in vermiwash 20% (43.333 mg and 12.867 mg in wheat and mustard respectively), GA (34.667 mg and 2.367 mg in wheat and mustard respectively), vermiwash 10% (24.667 mg and 1.9 mg in wheat and mustard respectively). The minimum RFW was observed in control (21.667 mg in wheat and 1.667 mg in mustard) seedlings (Graph 8).

Shoot dry weight

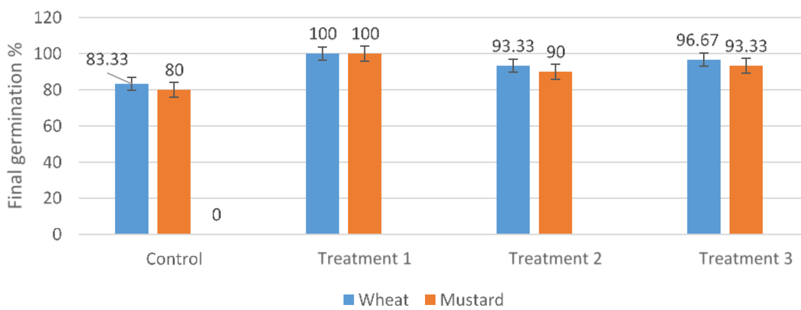
Collected data showed that shoot dry weight was positively affected in all treated seeds when compared to control seeds. The maximum RFW was recorded in vermiwash 20% (63.667 mg and 33.667 mg in wheat and mustard respectively), GA (59 mg and 18.333 mg in wheat and mustard respectively), vermiwash 10%



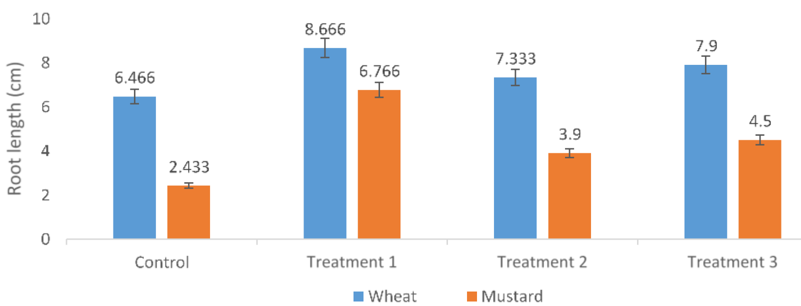
Graph 1: Comparative effect of different treatments: (Control: distilled water, Treatment 1: GA3, Treatment 2: 10% vermin-wash, Treatment 3: 20% vermin-wash) on wheat and mustard. Values are represented as means ± standard deviation of replications where control gives maximum value of mean germination time while GA3 gives minimum value.



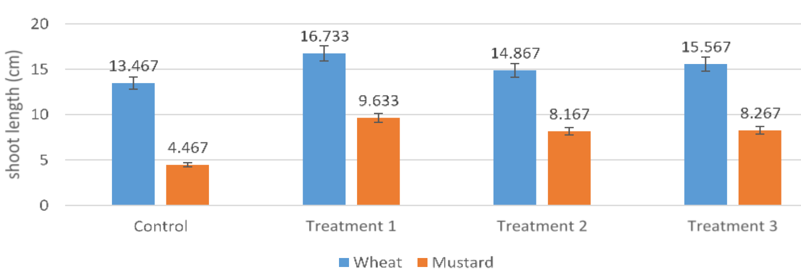
Graph 2: Values are represented as means ± standard deviation of replications where GA3 gives maximum value of germination index in both crops while control gives minimum value.



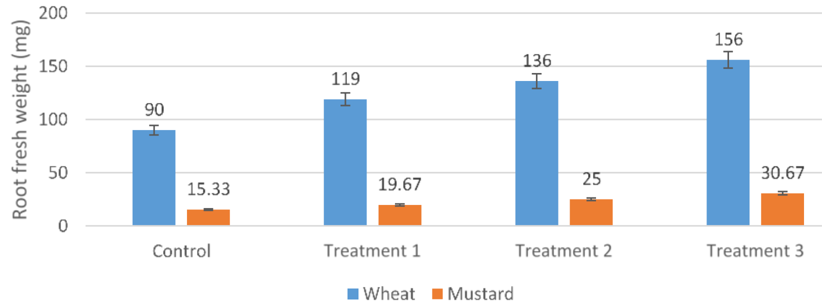
Graph 3: Values are represented as means ± standard deviation of replications where GA_3 gives maximum value of Final germination percentage in both crops while control gives minimum value.



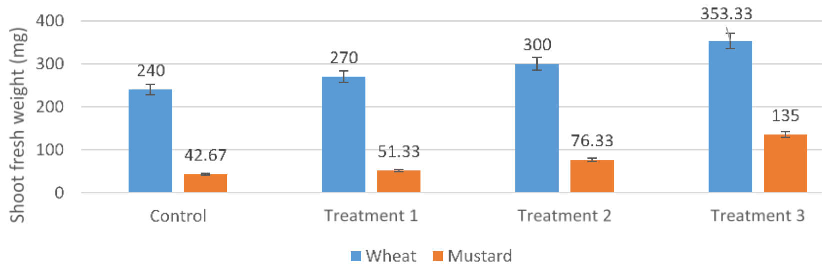
Graph 4: Values are represented as means ± standard deviation of replications where maximum value of Root length was observed in presence of GA3 and 20% vermiwash in both crops while control gives minimum value.



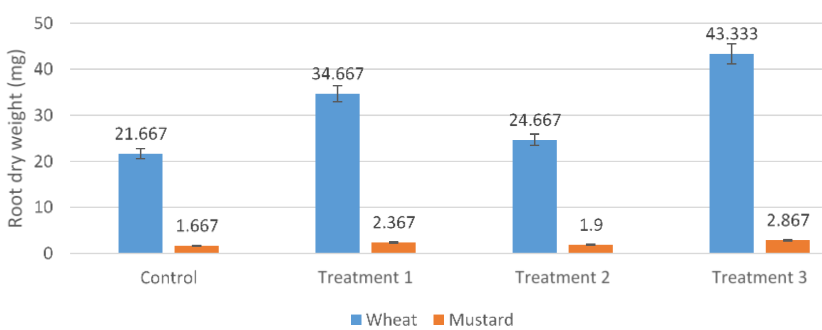
Graph 5: Values are represented as means ± standard deviation of replications where GA3 gives maximum value of Shoot length in both crops while control gives minimum value.



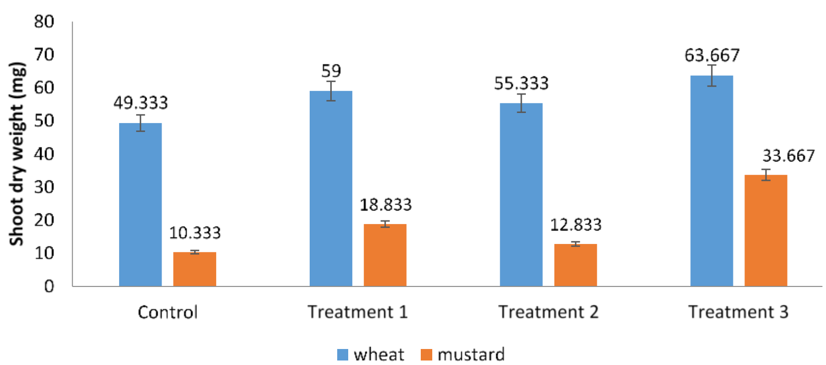
Graph 6: Values are represented as means ± standard deviation of replications where 20% vermiwash gives maximum weight of root in both crops while control gives the minimum.



Graph 7: Values are represented as means ± standard deviation of replications where maximum weight for shoot was recorded in presence of 20% vermiwash in wheat and mustard while control gives minimum value.



Graph 8: Values are represented as means ± standard deviation of replications where 20% vermiwash gives maximum value of root dry weight in both crops while control gives minimum value.



Graph 9: Values are represented as means ± standard deviation of replications where maximum dry weight for shoot was recorded in 20%vermiwash in both crops while control gives minimum value.

(55.333 mg and 12.833 mg in wheat and mustard respectively). The minimum RFW was observed in control (49.333 mg in wheat and 10.333 mg in mustard) seedlings (Graph 9).

DISCUSSION

A treatment of GA produced significantly supreme results in regard to growth parameters of both crops. Plants that were treated with 50 ppm GA produced more shoot length. Similarly, Atiyeh et al. (2002) concluded beneficial effects of vermiwash on germination, growth and the productivity of plants.

Majidi et al. (2016) observed maximum germination index, final germination percentage and seedling length in wild barley under application of GA. Kucera et al. (2005) studied that embryo in seed is surrounded by covering layers and gibberellic acid have the ability to overcome mechanical barriers enforced by these layers thus enhance germination by promoting embryo's growth potential. Therefore, GA results in maximum germination index and final germination (%). Abido et al. (2019) concluded that seed priming with GA brought an increase in germination and seedling establishment. They found that these outcomes may be owing to an important and vital role of GA_3in plant cycle and germination processes which includes cell division.

In the present study we observed that GI and length of root and shoot of wheat and mustard were significantly enhanced by applying 50 ppm gibberellic acid. Similar findings have been supported in castor (*Ricinus communis* L.) and cotton (*Gossypium barbadense* L.) seeds when GA3 was applied at appropriate concentration (Zhou et al., 2014). These results are supported by (Agarwal et al., 2003). An increase in the seedling length of very important vegetable crops such as *Hibiscus sabdariffa* and *Phaseolus aureus* have been reported by Fathima and Sekar (2014).

Kamithi et al. (2016) observed that seed priming promotes building up of metabolites that are responsible for seed germination. From these studies Khan et al. (2016) made a conclusion that improvement in germination parameters observed under vermipriming may be due to composition of vermiwash. Presence of water soluble micronutrients, macronutrients, microorganisms that promote plant growth and hormones in vermiwash facilitate osmotic regulation and metabolic repair during vermipriming results in better seed germination.

Conclusion

The present experiment revealed that pre-germination seed treatment with vermiwash and GA3 results in better germination of seed. Germination parameters were weight influenced positively under effect of 10% and 20% vermiwash and GA3 solutions treatments. Although GA improves the performance of seed germination but GA as a hormone can disturb metabolic pathways. Vermiwash as enrich source of essential nutrients and beneficial microorganisms not only improve germination but also increase soil fertility (Sundararasu, 2016). Thus for organic farming and maintaining ecosystem balance vermiwash is a better choice.

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Author’s contribution

AJ and MI did experiment, collected and analyzed data and MT supervised this research work.

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