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Significance of vermiwash on crop production: A review

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Abstract
Vermiwash is a rich source of vitamins, hormones, enzymes, macronutrients and micronutrients when applied to plants help in efficient growth. The comparative study was done on the effect of vermiwash on crop production capacities of soil by improve the physiochemical property of soil and reduced the insect-pest infestation which would have facilitated increased uptake of the nutrients by the plants resulting in higher growth and yield. It also helps in sustainable crop production.

Keywords: growth, nutrient uptake, sustainable, yield

Introduction
Presently use of chemical fertilizers is increasing in agriculture day by day which ultimately destroys the fertility of soil. Control the hazardous effect of chemical fertilizer can be reduce by the use of organic fertilizers. In this way, vermiwash may be used for better yielding of crops. Vermiwash protect the environment from various chemical fertilizers. Vermiwash is a liquid extract of organic waste material, which is collected after the passage of water through the different layers of earthworm culture units. Vermiwash is used as a liquid major nutritive and enzymatic element for promoting growth of all green plants Vermiwash, the extracted body fluid of earthworms is also nutrient rich with components promoting good plant growth (Gorakh Nath, *et al*., 2009) [12]. Very few researches are available in favour of vermiwash and its influence on the growth and development of plants. Earthworm has an efficiency to consume all types of wastage *viz,* that kitchen waste, temple waste, animal house waste, industrial waste, hospital waste and other organic wastes etc. Earthworms play a vital role in converting organic wastes to useful vemicompost. The dead worm's tissue discharges nitrogen in form of nitrates-25%, ammonia 45%, organic soluble compound 3% and other material 27% (Satchell, 1967) [25]. These materials improve the nutrient quality of vermiwash.

Properties of vemiwash
Vermiwash is coelomic fluid extraction contains several enzyme, plant growth hormones like cytokinins, gibberlines and vitamins along with mocro and macro nutrients (Buckerfield *et al*., 1999) [6]. In vermiwash nitrogen present in the form of mucus, nitrogenous excretory substances growth stimulating hormones and enzyme (Tripathi and Bhardwaj, 2004) [31]. Vermiwash bio-fertilizer was obtained from vermicomposting waste corn pulp blended with cow dung manure. The pH and electrical conductivity was higher in the vermicompost compared to the vermiwash. The nitrogen and potassium content were 57% and 79.6% higher in the vermicompost as compared to the vermiwash respectively. However, the phosphorous content was 84% higher in the vermiwash as compared to the vermicompost. The vermiwash was 89.1% and 97.6% richer in Ca and Mg as compared to the vermicompost. Furthermore, the vermiwash was 97.8% rich in sodium content compared to the vermicompost (Manyuchi *et al*., 2013) [16]. It increases the disease resistant power of crop, (Yadav *et al*., 2005) [15]. Varghese and Prabha (2014) [32] study suggests that, vermiwash revealed potential application in sustainable development in agriculture biotechnology with respect to its origin, cost effectiveness, availability, reproducibility, reliability as well as biopesticide and ecofriendly soil conditioner.

Effect of vermiwash on growth of crop
Vermiwash is very good liquid manure and affect significantly on the growth and productivity of crop during foliar spray (Subasashri, 2003) [27]. Application of 100% RDF + vermiwash @100 l ha^{-1} was recorded significantly the highest plant height, number of primary branches, number of secondary branches, leaf area index and dry matter accumulation as compare to

Other Treatments (Verma, 2017) [34]. Manuring with vermicompost or in combination with foliar spray of vermiwash (5 or 10%) recorded higher number of pods plant-1 (12.7-15.8) as compared to that in untreated control (7.9 pods plant^{-1}) and positively influenced nodulation and plant growth, and significantly increased number of pods plant^{-1}, number of seeds pod^{-1}(Mahto and Yadav, 2005) [36]. Tiwari and Singh (2016) [29] reported that foliar applications of combinations of vermiwash obtained from animal dung and MSW with bio-pesticides neem (*Azadiracta indica*) oil, aquous extract of leaf, bark and vermiwash alone caused significant growth, start early flowering, enhance productivity of tomato crop. The highest growth of tomato (50.09±1.29 cm) and maximum significant early flowring were observed after foliar application of mixture of vermiwash with neem oil in ratio of (2:1) whereas, the maximum significant early flowering period obtained after treatment of vermiwash of buffalo dung and MSW (2:1 ratio) with neem oil. Different combinations of vermiwash (buffalo dung) + gram bran with neem oil and aqueous extract of garlic is effective for increased the growth, early flowering and enhanced the productivity of gram up to three times over control (Nath and Singh, 2015) [21]. Combination of vermiwash obtained from buffalo dung + vegetable wastes with neem oil is very effective combination for growth and productivity of Soybean. It can be also stated that the use of foliar spray of vermiwash obtained from vermicomposts of buffalo dung + agro / kitchen wastes have sufficient potency to increase the growth, flowering, productivity and reduced pest's infestation of crop (Nath and Singh 2011) [20]. Use of vermiwash extracted from vermicomposts of different combination of animal agro and kitchen wastes, is one of the effective liquid biofertilizer for growth and productivity of crops. The present study assesses that it has caused significant effect on the growth and productivity of paddy (*Oryza sativa*), maize (*Zea mays*) and millet (*Penisetum typhoides*) crops. The 10mg m^{-2} of vermiwash buffalo dung with straw shows significant growth (89.2±2.7cm) and 30mg m^{-2} concentration of similar combination shows highly significant growth in paddy crops(102.6±2.3cm) after 75 days. The 10mg m^{-2} concentration of combination horse dung with gram bran caused significant growth (85.2±4.3cm) 50 days while at the same time 30 mg m^{-2} concentration of combination of straw with buffalo dung and horse dung caused highly significant growth in maize crops. The combinations of buffalo dung with gram bran and with straw; and combination of horse dung with gram bran and with straw have significant growth in millet crops. All the concentrations of different combinations of animal agro and kitchen wastes have significant early start in flowering and enhance the productivity of crops (Nath and Singh, 2012) [19]. Vermiwash at a higher dilution is able to bring about increased germination rate and enhanced seedling growth in plants studied. The degree of response of the plants has varied and this could be attributed to the physiology of the plants under consideration and the concentration of vermiwash needs to be standardized to suit the plant to which it is applied (Anasri and Sukhraj, 2010). Nutrients and growth promoting substances present in the vermiwash showed its potentiality in seed germination and seedling vigour (Chattopadhyay, 2015). The vermiwash were found to significantly increase the growth parameters of the mulberry plant and enhance the nutritive level of the mulberry leaves. Such leaves fed to the silkworm larvae (Bombex mori L) showed a significant positive effect on larval growth in terms of larval and silk gland weights and cocoon characters including fresh wet cocoon weights, wet weights of deflossed cocoons, dry weight of deflossed cocoons, and shell ratio percent as compared with controls (Rawgol *et al*., 2011) [24]. Kumar *et al*., (2013) observed that the application of vermiwash enhanced plant height and number of leaves (56.29 cm and 6.14 days at 45 days after bud emergence), spike length and rachis (90.68 cm and 47.07 cm), number of florets (15.08), vase-life (10.02 day) number of corms m-2 (28.66), weight of corms (50.68 g) and number of cormels plant-1 (56.66). Same treatment was also effective to reduce number of days taken to spike emergence (81.73 day). Nath and Singh (2016) [22] reported that the effect of vermiwash of different vermicomposts of animal agro and kitchen wastes observed on the growth, flowering periods and productivity of different *Rabi* crops viz. wheat, gram, pea and mustered. In case of wheat after 30 days of sowing the vermiwash of combination of goat dung with wheat and goat dung with vegetable wastes shows higher 26.20±0.97 and 26.45±0.53 cm growth respectively, where as the maximum growth 65.00±0.88 observed in conc. of 30 mg m^{-2} of combination of buffalo dung with rice bran. The significant productivity observed in combination of buffalo dung with rice bran i.e. 0.496±0.01 kg m^{-2} which is followed by the treatment of 10 mg m^{-2} concentration buffalo dung with rice bran. The highest significant productivity recorded in goat dung with wheat bran i.e. 0.621±0.06 kg m^{-2} conc. in 30 mg m^{-2}. Chauhan and Singh (2015) reported that the significance germination of okra seed in vermiwash with aqueous extract of neem bark (VW+NB) 97±5.21% than other combinations and early germination was observed (11.48±0.49 days). The maximum height of okra 42.42±0.79 cm was observed in after 90 days by sprays of VW+NB. The combination of VW+NF was important for high productivity of okra. The maximum productivity of okra plant was observed 773.23±20.64 g m-2 in treated with VW+NF.

Effect of vermiwash on yield attribute and yield

Application of 100% RDF+vermiwash @100 l ha^{-1} was recorded significantly the highest pods plant^{-1}, grains pod^{-1}, test weight, grain and stalk yield of pigeonpea as compare to other treatments (Verma, 2016) [33]

Foliar spray of vermiwash (at 50 l ha^{-1}) and water at 15, 35 and 50 days of crop age and the water spray was given to the remaining plots as per treatment. The foliar spray of vermiwash recorded higher number of branches (3.23) over water spray (2.96). The mean grain yield was significantly higher (10.42 q ha^{-1}) with vermiwash compared to water spray (9.68 q ha^{-1}) (Khairnar *et al*., 2012). Effect of vermi products and found that combined uses of vermicompost + vermiwash (5 or 10%) gave higher fresh yield of vegetable pea plant-^{1} by approximately 70% over control (Mahto and Yadav, 2005) [15]. Nath and Singh (2009) [23] observed that different comination of vermiwash of animal and kitchen wastes have better growth and productivity of crops. The vermiwash is less expensive than chemical fertilizers, easily producible, eco-friendly and one of the best organic manure for foliar spray on the different crops. Ansari and Sukhraj (2010) [2] study revealed that combination of vermicompost and vermiwash combination [VW+VC] showed a significantly greater yield response of okra by 64.27% as compared with the control. Esakkiammal *et al*., (2015) [9] reported that the combination of vermicompost and vermiwash showed maximum positive effects on the growth and yield of lablab beans. Application of vermiwash increases growth, flowering and corm yield characters of gladiolus when they are applied

along with recommended fertilizers doses (Kumar *et al*., 2012). Tiwari and Singh (2015) [30] reported that the foliar application of aqueous mixture of combination of vemiwash with neem oil, leaf and bark have increased the brinjal plant growth, early flowering, increased productivity. Organic formulations could be a potent source to improve crop productivity and quality and additionally control of pest and diseases. This could additionally make a possibility elective to fertigation which is becoming common in most of the crops (Verma *et al.,* 2017) [34].

Effect of vermiwash on quality of grain

The application of 100% RDF+vermiwash @100 l ha^{-1} was recorded highest protein yield as comare to other treatments (Verma, 2016) [33]. Use of biological inputs and organic materials to improve the quality of crops and increase production without extension of cultivated lands is a significant issue in hydroponics (soilless culture) culture. The factors included two cultivars of tomato, and four nutrient solution (manure vermiwash, mixed vermiwash, manure compost tea, mixed compost tea), with soil bed as control. The results showed that the effect of nutrient solutions and interaction effect between variety and the nutrient solution were significant for all traits except for root dry weight. The results of qualitative traits analysis of extracts showed that the effect of nutrient solutions for the elements of phosphorus and potassium was not significant but for the other elements there were significant difference at the 1%level of probability (Allahyari *et al*., 2014). Ansari and Sukhraj (2010) [2] reported that combination of vermicompost and vermiwash [VW+VC] recorded greater percentage of fats and protein content in okra as compare to control. Edwards *et al.,* (2004) [8] have been reported that vermiwash influence the fruit quality. Organic formulations have potential to enhance the quality of crop (Verma *et al*., 2017) [34].

Effect of vermiwash on insect-pest

Combined uses of vermicompost + vermiwash (5 or 10%) gave better performance with lower pest infestation in vegetable pea by 24.26% over control (Mahto and Yadav, 2005) [15].

Organic formulations have to capacity to reduce pest and diseases infestation (Verma *et al*., 2016) [33]. Foliar applications of combinations of vermiwash obtained from animal dung and MSW with bio-pesticides neem (Azadiracta indica) oil, aquous extract of leaf, bark and vermiwash alone caused significant reduction (P>0.05) in pest infestation of tomato crop (Tiwari and Singh, 2016) [29]. Vermiwash (buffalo dung) + gram bran with neem oil and aqueous extract of garlic is effective for the control of pod borer infestation on gram plant (Nath and Singh, 2015) [21]. Gopalakrishnan *et al*., (2015) conducted an experiment on washings of vermicompost (called biowash or vermiwash) prepared from foliage of Jatropha (*Jatropha curcas*), Annona (*Annona squamosa*) and Parthenium (*Parthenium hysterophorus*) and evaluated against fungal pathogens viz. *Fusarium oxysporum* f. sp. ciceri (FOC; causes wilt in chickpea), *Sclerotium rolfsii* (causes collar rot in chickpea) and *Macrophomina phaseolina* (causes charcoal rot in sorghum). Crude biowash of the botanicals were partitioned against ethyl acetate and the resultant organic and aqueous fractions were tested against the fungi. Vermiwash acts as pesticide, disease curative and crop tonic and increase the yield of lab lab beans (Esakkiammal *et al*., 2015) [9]. Mishra *et al.,* (2015) [18] concluded that the vermiwash with bio-pesticide is the better option of the chemical fertilizer and pesticides for the management of *Leptocoryza varicornis* as well as productivity of rice crop. Since vermiwash is mild biopesticides and plant allelochemicals in their combination shows synergistic effect reduce the Leptocoryza varicornis population which ultimately enhances the productivity. Mishra et al., (2014) [17] concluded that the vermiwash with bio-pesticide is the better option for the growth, productivity as well as management of *Lucinodes orbanalis* infestation on brinjal crop. The foliar spray of vermiwash provide necessary nutrients to the growing plant for elongation, early flowering and fruiting phase. The bio-pesticide are more effective against larvae and caterpillar of fruit and shoot borer without contamination of fruits, so it is the best alternative of chemical fertilizers and pesticides for management of Lucinodes *orbanalis* population and enhancement of the productivity of fruit yield.

Effect of vermiwash on soil property

Organic formulations could be a potent source to move forward soil fertility (Verma *et al*., 2017) [34]. Combination of vermicompost and vermiwash [VW+VC] recorded a significant influence on the biochemical characteristics of the soil with marked improvement in soil micronutrients and better qualitative improvement in the physical and chemical properties of the soil (Ansari and Sukhraj, 2010) [2]. Tharmaraj *et al*., (2011) reported that soil treated with mixture of vermicompost and vermiwash had significantly improve soil physico-chemical properties comparison to unamended soil.

Role of vermiwash in sustainable of crop production

Vermiwash revealed potential application in sustainable development in agriculture biotechnology with respect to its origin, cost effectiveness, easily availability, time saving, reproducibility, reliability and eco-friendliness (Zambare *et al*., 2008). It can be used as a potent biofertiliser to improve the germination and seedling survival rates in crop plants growing on nutrition depleted soils thus paving the way for sutainable agriculture using organic farming practices (Fathima and Sekar 2014). It could be utilized effectively for sustainable plant production at low input basis green farming (Edwards *et al*., 2004) [8]. It recorded significant growth and productivity in the black gram (Sobha *et al*., (2003) [26]. Weerasinghe *et al*. (2006) have suggested that vermiwash is a natural growth supplements for tea, coconut and horticultural crops.

Conclusion

The effect of vermiwash was observed on the plants and it was found that the results obtained were almost similar to the results of vermicompost. The vermiwash proves to be an effective fertilizer which contributes the growth, yield of plants when sprayed directly as well as mixed with a definite ratio of fertilizer or manure. It was also observed that the plants treated with vermiwash were reduced insect-pest population. Experiment shows that vermiwash along with vermicompost can be used as a substituent of commercial fertilizers available in market however the effect of other parameters has to be analyzed.

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