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RESEARCH ARTICLE

INFLUENCE OF SOLARIZATION WITH BIO-AMENDMENTS ON SOIL PROPERTIES OF CLUSTER ONION FIELD

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ABSTRACT

Onion (*Allium cepa* L.Var. aggregatum Don.) is one of the most important bulb vegetable crops grown in India and around the globe. The recent string in solarization is combining it with organic amendments like animal waste and plant residues that are capable of producing toxic volatiles. During the process of solarization with amendments, bio toxic volatile compounds are released when organic matter is heated. Such a treatment was reported to result in certain physical, chemical and biological changes that favour plant health and growth while producing deleterious effect on weeds, pathogens and pests and also increasing the nutrients availability of the soil and crop uptake. Hence an experiment was conducted to find out the influence of soil solarization after amending the soil with various bulky organic manures and concentrated oil cakes. The experiment was laid out in a randomized block design with 14 treatments replicated thrice. The treatments include a combination of solarization for four weeks with three different amendments viz., Vermicompost (5 t ha^{-1}), Farm Yard Manure (FYM)(12.5 t ha^{-1}), and neem cake(1 t ha^{-1}) along with non solarized control and solarization without amendment. The results of the experiment revealed that solarization treatment with vermicompost and neem cake was found to be effective in increasing the soil temperature in all depths and on all days of observation and significant increase in the available nutrients of soil. The chemical and biological properties of onion field were found to be the best in the treatment combination of solarization for 4 weeks with vermicompost @ 5 t ha^{-1}, neem cake @ 1 t ha^{-1}, consortium bio fertilizers @ 2 kg ha^{-1} and foliar application of panchakavya @ 4 % sprayed 4 times and it could be adjudged as the best treatment combinations for maximizing the productivity of onion.

Key words: Cluster onion, solarization, organic manures, consortium biofertilizers.

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INTRODUCTION

Onion is one of the most important bulb vegetable crops grown in India and around the globe. The demand for onion is worldwide. It is used both in raw and mature bulb stage as vegetable and spices. The pungency in onion is due to a volatile oil known as allyl-propyldisulphide. It is rich in vitamin A, thiamine and riboflavin. It also contains calcium 32 mg and protein 1.4 mg per 100 g of bulb. In view of the increased awareness about organic farming, investigation on pesticide residue free food production and increased application of organic inputs have become imperative to assess their combination and their effect on yield, quality and post harvest storage life of vegetables. Soil solarization involves covering moist soil with transparent polyethylene sheet during hot months for sufficient time to raise the soil temperature to the levels lethal for soil borne pests such as weeds, insects, disease pathogen, nematodes, etc.

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Artificial soil heating or soil solarization is the only non-chemical soil disinfestation method which has been tested on a large scale under farming conditions. Combining organic amendments with soil solarization is a developmental approach for the control of soil borne plant diseases (Jeffschalan, 2003). During the process of solarization with amendments, bio toxic volatile compounds are released when organic matter is heated. Such a treatment was reported to result in certain physical, chemical and biological changes that favour plant health and growth while producing deleterious effect on weeds, pathogens and pests and also increasing the nutrients availability of the soil and crop uptake. Based on the above said requisites an investigation was conducted to study the impact of solarization with organic amendments, biofertilizers and bio regulators on soil properties of cluster onion field and productivity of cluster onion.

MATERIALS AND METHODS

The experiment was conducted to find out suitable organic practices for augmenting the productivity of cluster onion by adopting organic practice involving solarization with various amendments and nutrient management through various bulky organic manures, concentrated oil cakes, biofertilizers and foliar organic nutrition. The experiment was laid out in a randomized block design with 14 treatments replicated thrice. The treatments include a combination of solarization for four weeks with three different amendments viz., Vermicompost (VC), Farm Yard Manure (FYM), and neem cake(NC) along with non solarized control and solarization without amendment. The treatment details are Conventional farming practices (60: 60: 30 kg NPK ha^{-1}) without solarization (T_1); Conventional farming practices (60: 60: 30 kg NPK ha^{-1})+ Solarization(T_2); FYM (12.5 t ha^{-1}) + CBF (2 kg ha^{-1})+ No solarization(T_3); FYM (12.5 t ha^{-1}) + Consortium Bio Fertilizers (2 kg ha^{-1})+ Solarization(T_4); Vermicompost(5 t ha^{-1}) + CBF (2 kg ha^{-1})+ No solarization (T_5); Vermicompost(5 t ha^{-1}) + CBF (2 kg ha^{-1})+ Solarization (T_6); FYM+ CBF+ Neemcake (1 t ha^{-1})+ No solarization(T_7); FYM+ CBF+ Neemcake (1 t ha^{-1})+ Solarization(T_8); VC + CBF+ Neemcake (1 t ha^{-1})+ No solarization(T_9); VC + CBF+ Neemcake (1 t ha^{-1})+ Solarization(T_{10}); FYM+ CBF+ NC +Panchakavya(4 %)+ No solarization(T_{11}); FYM+ CBF+ NC +Panchakavya(4 %)+ Solarization(T_{12}); VC + CBF+ NC +Panchakavya(4 %)+ No solarization (T_{13}); VC + CBF+ NC +Panchakavya(4 %)+ Solarization(T_{14}). The plots were irrigated to field capacity to encourage exothermic fermentation process. After irrigation, the plots were covered with the low density poly ethylene sheet of 0.05 mm thickness and the sides were tucked into the soil. The plots were solarized for a period of four weeks and monitored carefully. After the solarization period was over, the polyethylene sheets were removed and Consortium Bio Fertilizers (CBF) was applied in the respective treatments as band application after 2 days of sheet removal. In onion, the popular cultivar used in this experiment was Co 5. Panchakavya @ 4 % was given as a foliar spray for 4 times.

RESULTS AND DISCUSSION

Perusal of the data presented in Table 1 revealed that the microbial and nematode population differed significantly due to solarization with various amendments. The least number of fungal colonies (14.64 x 10^{-3} per gram of soil), bacteria (15.28 x 10^{-1}), actinomycetes (13.36 x 10^{-5} per gram of soil) and lowest number of larvae of nematodes (10.85) were recorded in the treatments which received solarization with Vermicompost and neem cake (T_{14}),whereas the highest population of fungi (33.15 x 10^{-3} per gram of soil), bacteria (36.65 x 10^{-1} per gram of soil), actinomycetes (224.63 x 10^{-5} per gram of soil) and nematode (20.13) was recorded in T_1 (control). The soil microbial population significantly reduced due to solarization with amendments. The least value of fungal colonies, bacteria and actinomycetes population was recorded in the treatments solarization with neem cake and vermicompost. This might be due to the release of bio toxic volatiles (Pleog, 2001) from amendments during the period of solarization. This process otherwise called, Bio-fumigation causing lethal effect on soil borne pests and diseases is caused by a combination of the direct effect of toxic substances from the decomposing bio-fumigants, and the long-term increase of soil temperature. Many soil borne organisms is controlled and/ or made more susceptible to hyper parasitism by prolonged exposure to the sub-lethal temperatures obtained as observed in the present study; which is in accordance with studies of Selvaganesh (2006) in mesta.

Table 1. Effect of solarization in bio amended soil on Soil microbial population after one month of solarization

Treatments	Fungi x 10^{-3}	Bacteria x 10^{-1}	Actinomycetes x 10^{-5}	Nematodes (No of larvae/ 10 ml of suspension)
T_1	33.15	36.65	24.63	20.13
T_2	23.85	25.82	18.96	15.47
T_3	31.62	34.90	23.70	19.36
T_4	22.31	24.06	18.03	14.70
T_5	30.08	33.15	22.76	18.59
T_6	20.77	22.30	17.10	13.92
T_7	28.54	31.41	21.82	17.83
T_8	19.22	20.54	16.17	13.16
T_9	26.95	29.67	20.88	17.05
T_{10}	16.14	16.98	14.26	11.60
T_{11}	26.99	29.31	20.85	17.01
T_{12}	17.69	18.78	15.25	12.39
T_{13}	25.38	27.57	19.90	16.24
T_{14}	14.64	15.28	13.36	10.85
S.Ed.	0.76	0.87	0.46	0.38
CD(p=0.05)*	1.52	1.73	0.92	0.76

Table 2. Effect of solarization in bio amended soil on post harvest soil nutrient status (kg ha-1) in cluster onion

Treatments	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potassium (Kg ha^{-1})
T_1	161.52	18.76	175.32
T_2	164.09	19.51	181.08
T_3	166.68	20.26	186.83
T_4	171.83	21.77	198.63
T_5	169.26	21.01	192.63
T_6	174.41	22.53	204.32
T_7	176.99	23.58	210.10
T_8	187.31	26.33	238.23
T_9	179.57	24.04	215.91
T_{10}	189.90	27.10	238.99
T_{11}	182.15	24.81	221.71
T_{12}	192.49	27.86	244.75
T_{13}	184.73	25.57	227.47
T_{14}	195.07	28.62	250.75
S.Ed.	1.29	0.38	2.90
CD(p=0.05)*	2.57	0.75	5.75

The significance of vermicompost in tolerating the infection of *Macrophomina phaseolina* causing dry root rot in garden bean is the presence of antagonistic micro organisms like actinnomycetes, lytic and nitrosomonas bacteria was reported by Sajitha *et al*., 2005. The data with regard to post harvest availability of soil nitrogen is shown in Table 2. Significant response to various levels of organic manures was observed for available nitrogen in soil than inorganic fertilizers. The maximum (195.07 kg ha^{-1}) was observed due to solaraization with vermicompost+ neem cake+ CBF+ panchakavya followed by solaraization with FYM+ neem cake+ CBF+ panchakavya which registered a value of 192.49 kg ha^{-1}. Application of inorganic fertilizer+ without solarization registered a value of 161.52 kg ha^{-1} for this character. Significant response for soil available phosphorus was observed due to various levels of organic manures and inorganic fertilizers. Among the treatments, the maximum response was observed in T_{14} (28.62 kg ha^{-1}) followed by T_{12} (27.86 kg ha^{-1}). The least value for soil available phosphorus was recorded in T_1 (18.76 kg ha^{-1}) as shown in Table 2.

The data with regard to post harvest available potassium in soil is shown in Table 2. When compared to that of control, all the treatments exerted significant differences for this trait. The highest residual potassium content of soil was recorded in treatment T_{14} (250.75 kg ha^{-1}) followed by T_{12} (244.75 kg ha^{-1}), T_{10} (238.99 kg ha^{-1}) in order. The least value for soil available potassium was recorded in T_1 (175.32 kg ha^{-1}). Significant variation was observed among the treatments for the trait, post harvest nutrient status of soil. Results on analysis of nutritional changes in plots solarized with amendments revealed significant increase in the available nutrients of soil. The available nitrogen, phosphorus and potassium content increased with solarization treatments and the values differed according to the type of organic manures used. The reason can be endorsed with two major factors as suggested by Haynes (1987), (a) under plastic film cover, soil moisture and soluble nutrients such as nitrates move upward by capillary movement, (b) the rate of mineralization of soil organic nitrogen might have been stimulated by relatively more moisture present under polythene cover. Stapleton *et al*. (1985) also observed that higher soil temperature under polythene cover would have further stimulated nitrogen mineralization.

The maximum availability of nitrogen, phosphorus and potassium were obtained with application of vermicompost along with neem cake, CBF and panchakavya in solarized plot. This might be due to the fact that vermicompost was found to enhance the number of nitrogen fixing bacteria and symbiotic microbial association thereby contributing to increase in nitrogen, phosphorus and potassium in soil. One another reason may be the higher amount of total and mineral nitrogen level as ammonia in the vermicompost that could be rapidly converted to nitrate thus minimizing the loss of N from soil. According to Reddy and Mahesh (1995), an increased availability of nitrogen in soil by the application of vermicompost compared to FYM is due to mineralization of native 'N' by higher bacterial population. The microbiological properties of soil could influence in decomposition of organic matter and enzymatic activities in soil (Nannipieri *et al*., 1990). This also might be the reason for increasing the availability of nutrients. Addition of organic manures provided sufficient quantity of carbonaceous materials for decomposition by microorganisms and converting them into mineralized organic colloids besides adding them to soil reserves. According to Bouton *et al*. (1979) *Azospirillum* fixes atmospheric nitrogen into the soil through biological mechanism thereby increasing the N availability of soil. Application of phosphobacteria is known to convert the insoluble form of phosphorus into soluble form and thus makes it available to the soil as reported by Hayman (1975). The increased N and P availability might have increased the K availability. This is in accordance with the finding of Shelke *et al*. (2001). Finally it is concluded that the chemical and biological properties of onion field were found to be the best in the treatment combination of solarization for 4 weeks with vermicompost @ 5 t ha^{-1}, neem cake @ 1 t ha^{-1}, consortium bio fertilizers @ 2 kg ha^{-1} and foliar application of panchakavya @ 4 % sprayed 4 times and it could be adjudged as the best treatment combinations for maximizing the productivity of onion.

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