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Effects of non-chemical weed and nutrient management on soil available nutrient, uptake, micronutrients, and nutrient balance in organic brinjal production systems (*Solanum melongena* L.)

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Abstract
The present experiment entitled "Development of organic farming package for brinjal (*Solanum melongena* L.)" was conducted during *kharif* season of the year 2017 and 2018 at Research Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra (India). The experiment was laid out in strip plot design with three replications. The main plot treatments were applied to brinjal comprised of non-chemical weed control modules *viz. Gliricidia* leaf mulching @ 5 t ha^{-1}, Biodegradable mulch (soybean straw) @ 5 t ha^{-1}, Mechanical (hoeing) intercultivation and pulling of weeds, Control -Weedy check, Weed free (Hand weedings with 15 days interval). Different organic nutrients sources and biofertilizers *i.e. Azospirillum* and *PSB* as a (1:1) @ 500 g 10 lit^{-1}) as sub plot treatments which comprised of seven organic sources treatments *viz.*, 100% RDN through FYM with biofertilizers, 100% RDN through vermicompost with biofertilizers, 100% RDN through neem cake with biofertilizers, 50% RDN each through FYM and vermicompost with biofertilizers, 50% RDN each through FYM and neem cake with biofertilizers, 50% RDN each through vermicompost and neem cake with biofertilizers, 1/3 N each through FYM, vermicompost and neem cake with biofertilizers. Total nutrient uptake and available nutrient of nitrogen, phosphorus and potassium was significantly higher due application of organic nutrient sources 50% RDN each through FYM and VC with biofertilizers of brinjal crop during both the years of experimentation. At the end of two seasons, micronutrients were slightly influenced due to application of different organic nutrient sources. The results indicated that cultivation of *kharif* brinjal with non-chemical weed control modules of keeping the crop weed free up to 80 days after transplanting by adapting five hand weeding (at an interval of 15 days) or by four mechanical (hoeing) intercultivation and pulling of weeds between the rows (20 days interval from 20 to 80 days after transplanting) and application of 50 per cent nitrogen 50 N kg ha^{-1}) each through farmyard manure and vermicompost with biofertilizers (*Azospirillum* and *PSB*) along with organic plant protection measures found suitable organic farming package for higher productivity and sustaining soil health.

Keywords: Organic brinjal, weed, nutrients, uptake, available nutrients, micronutrients

Introduction
Brinjal (*Solanum melongena* L.) is one of the most common tropical vegetable grown in India. It is a versatile vegetable crop grown as a poor man's crop, adapted to different agro-climatic regions and can be grown throughout the year. It is an important vegetable due to its nutritive value, consisting of minerals like iron, phosphorus, calcium and vitamins like A, B and C. Our demand by 2020 will be around 250 million tonnes of vegetables (Anon, 2017-18) [1]. In India, brinjal occupies an area of 10 lakh ha with a production of 1.87 million tonnes with average productivity of 17.96 t ha^{-1} (Anon, 2018-19) [2]. In Maharashtra, it is cultivated over an area of 68 thousand ha with a production of 11 lakh million tonnes with an average productivity of 17.00 t ha^{-1} (Anon, 2018-19) [2]. Among the various factors responsible for the low productivity of brinjal, weed menace and nutrient status of soils are considered to be major ones. There is tremendous scope for increasing the yield of brinjal up to 60 t ha^{-1}. Weeds can be considered a significant problem because they tend to decrease crop growth and yields by increasing competition for soil moisture, sunlight, space and nutrients while serving as host

plants for pests and diseases. On account of the early establishment and faster growth characteristic, weeds tend to have an upper hand on the crop. Among the various kinds of pests, the yield reduction in brinjal due to weed alone range from 49 to 90 per cent (Reddy *et al.*, 2000) [14]. Soil coverage with organic mulches is one of the natural methods of preventing weed infestation. It can be achieved by using plant mulches and mulches from straw left after the cereal grain harvest. Despite the serious threat, weeds offer to organic crop production relatively little attention has so far be paid in research on weed management in organic in general and brinjal in particular. There are several alternatives for the supply of soil nutrients from organic sources like farmyard manure, green manure, compost, vermicompost, organic cakes and biofertilizers etc., which also supplement the secondary micronutrients to crops. Soil fertility management is an important and costly cultural practice for organic vegetable growers. Complete organic production warrants the use of organic sources in plant nutrition, plant protection and all other related crop production practices. Cultivation of any crop depends on several factors and sources of nutrients are one of them. Organic sources of nutrients are less expensive and friendly to the environment. To minimize the economic return avoiding health hazards and for sustainable agriculture, the use of organic sources of nutrients should be encouraged. FYM, Vermicompost and Neem seed cake are commonly used sources of N for vegetables because they are relatively inexpensive and offer additional nutrients for soil improvement in addition to N. The use of biofertilizers in such a situation is, therefore, a practically paying proposal. P solubilizers are biofertilizers that solubilize phosphorus in soil and make it available to plants while *Azospirillum*, a heterotrophic nitrogen-fixing organism has been reported to be beneficial and economical on several crops. They improve growth and yield as well as the productivity of crops.

Material and Methods

Field experiment entitled "Development of organic farming package for brinjal (*Solanum melongena* L.)" was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri, during two successive years *viz.*, 2017 and 2018, respectively. The experimental soil was clay loam in texture, alkaline in reaction (pH 8.17) with electrical conductivity 0. 29 dSm^{-1}. The soil was low in organic carbon (0.52%) and available nitrogen (181.33 kg ha^{-1}), medium in available phosphorus (15.79 kg ha^{-1}) and very high in available potassium (403.56 kg ha^{-1}), respectively. The bulk density, infiltration rate, field capacity, permanent wilting point and porosity of the soil were 1.33 g m^{-3}, 8.71 cm hr^{-1}, 36.30, 18.32 and 47.33 per cent, respectively. Thus soil was suitable for growing of brinjal in *kharif* season. The experiment was laid out in strip plot design with three replications (Fig. 3.3). The main plot treatments were applied to brinjal comprised of non-chemical weed control modules *viz.* W_1 - *Gliricidia* leaf mulching @ 5 t ha^{-1}, W_2 -Biodegradable mulch (soybean straw) @ 5 t ha^{-1}, W_3- Mechanical (hoeing) inter cultivation and pulling of weeds, W_4- Control -Weedy check, W_5- Weed free (Hand weedings with 15 days interval). Different organic nutrients sources and biofertilizers *i.e. Azospirillum* and *PSB* as a (1:1) @ 500 g 10 lit^{-1}) as sub plot treatments which comprised of seven organic sources treatments *viz.*, O_1- 100% RDN through FYM with biofertilizers, O_2-100% RDN through vermicompost with biofertilizers, O_3-100% RDN through neem cake with biofertilizers, O_4-50% RDN each through FYM and vermicompost with biofertilizers, O_5-50% RDN each through FYM and neem cake with biofertilizers, O_6- 50% RDN each through vermicompost and neem cake with biofertilizers, O_7- 1/3 N each through FYM, vermicompost and neem cake with biofertilizers. The climatic condition was favorable for crop during both the years. The total rainfall received during crop growth period was 486.9 mm and 139.2 mm in 20 and 09 rainy days and it was 8.23 and 73.59 per cent less during first and second year as compared to average annual rainfall (527 mm). But maximum and minimum temperature as well as morning and evening relative humidity was in optimum range which create congenial condition for optimum growth of crop. Brinjal Cv. *Manjarigota* was used as a test crop which is suitable for irrigated condition. It was procured from the Vegetable Scheme, M.P.K.V., Rahuri. It is indeterminate and open pollinated variety. Generally organic farming, the open pollinated or deshi type variety is used as a test crop because it's not contains any hybridizing material. As per the treatments mulch of *gliricidia* leaf on wet weight basis @ 5 t ha^{-1} and soybean straw on dry weight basis @ 5 t ha^{-1} applied two days after transplanting of the brinjal crop. As per the treatments mechanical (hoeing) inter cultivation carried out by machine operated hand hoe at 20, 40, 60, 80 DAT. As per the treatment hand weeding in weed free plot was carried out by weeding hook i.e. five hand weeding at 15 days intervals to keep plots weed free up to 80 days. As per the treatments details biofertilizers *viz.*, *Azospirillum* and Phosphate solubilising bacteria (*PSB*) were used for root inoculation of brinjal seedlings (Root dipping). For the preparation of biofertilizers solution 250 g of *Azospirillum* and 250 g of Phosphate solubilising bacteria (*PSB*) were mixed in ten litre of water in plastic container. Immediately after uprooting 30 days old seedlings from plastic pro-trays, the roots of the required seedlings were dipped in the mixed bacterial solutions for 10 minutes under shade and then the seedling were used for transplanting in experimental plot. The required quantity of FYM, vermicompost and neem cake was incorporated in the soil before transplanting of brinjal seedling followed by irrigation. Before application, these organic sources were analyzed for their nutrient content by using standard analytical method. The nutrient content of various organic sources (FYM, vermicompost and neem cake) are furnished below.

Organic Sources	Nutrient content (%)					
	2017			2018		
	N	P	K	N	P	K
Farmyard manure	0.69	0.40	0.78	0.70	0.45	0.85
Vermicompost	1.73	0.82	0.90	1.74	0.84	0.95
Neem cake	4.15	1.30	1.55	4.19	1.30	1.55

Plant and weed samples were collected from each replication of each treatment after harvesting of crop in both the years of experimentation. The plant and weed samples were sundried first for the period of 10 days and then kept in hot air oven at 60^0C till constant weight was obtained. The dried samples were grinded in stainless still Willey mill to fine powder and analyzed for N, P and K content by adopting standard analytical methods such as Micro-Kjeldhal's, Vanadomolybdate yellow colour method in nitric acid system and Flame photometer, respectively given by Jackson (1973). The uptake of N, P and K was calculated by multiplying the nutrient concentration to dry matter of weed and fruit yield in brinjal crop during both the years.

Total N, P and K uptake in crop were worked out. The nutrient (NPK) uptake was worked out by using following formula.

Nutrient uptake (kg ha^{-1}) = Nutrient concentration (%) x Biomass dry matter (kg ha^{-1}).

The balance of available N, P and K in soil was calculated as nutrient balance using following formula.
(Initial available nutrient in soil + nutrient added through different organic inputs) – (Total nutrient uptake by crop and weeds + Nutrient balance in soil after harvest of crop)

Net loss or gain (kg ha^{-1}) = Actual balance at harvest – Computed balance

Gain (kg ha^{-1}) = Actual balance at harvest > Computed balance

Loss (kg ha^{-1}) = Actual balance at harvest < Computed balance

The experimental data was subjected to analysis adapting data obtained on various variables were analyzed by 'Analysis of Variance' method (Panse and Sukhatme, 1985) [12]. Data analyzed by using strip plot design. Wherever, the results were found to be significant, critical difference was calculated at P=0.05 by the formula.

C.D. = S.E.m± x 2 x t at error d.f.

The pooled analysis was carried out as per the procedure outlined by Cochran and Cox (1957). The homogeneity of error variance was tested by applying the Bartlett's test.

Results and Discussion

Effect of non-chemical weed control modules on nutrient uptake by brinjal crop (kg ha^{-1})

Weed management practices significantly influenced the N, P, and K uptake by brinjal crop at harvest showed in Table 1. The significantly higher N (125.43 and 134.85 kg ha^{-1}), P (25.71 and 28.67 kg ha^{-1}) and K (278.72 and 282.49 kg ha^{-1}) uptake was observed in weed free treatment as compared to other weed management treatments during 2017 and 2018 except hoeing and pulling of weeds in which N (121.46 and 130.13 kg ha^{-1}) and P (23.92 and 27.67 kg ha^{-1}) uptake was at par during the year 2017 and 2018 whereas K uptake (277.14 kg ha^{-1}) was at par during 2018. Significantly lower values of N uptake were observed in weedy check as compared to other treatments. This weed free treatments recorded 78.95 and 75.26 per cent, 65.65 and 58.83 per cent, 56.73 and 52.77 per cent higher N, P and K uptake and hoeing and pulling of weeds recorded 73.29 and 69.13 per cent, 54.12 and 53.29 per cent, 53.74 and 49.87 per cent higher N, P and K uptake as compared to unweeded check treatment during the year 2017 and 2018 respectively. This may be attributed to minimum crop weed competition as results of better weed control of weeds from initial stage resulting in better brinjal growth and development of crop leading to better nutrient uptake. These results are in confirmatory with those reported by Patel and Virdia (2011) [13] and Vidyasagar *et al.* (2018a) [16].

Effect of organic nutrient sources on nutrient uptake by brinjal crop (kg ha^{-1})

In Table 1 Among the organic nutrient sources crop supplied with 50% RDN each through FYM and VC with biofertilizers recorded significantly higher N (115.25 and 120.57 kg ha^{-1}), P (24.60 and 28.67 kg ha^{-1}) and K (259.79 and 264.17 kg ha^{-1}) uptake by brinjal crop at harvest as compared to other treatments of organic sources of nutrients during 2017 and 2018, respectively except as it 50% RDN supplied each through FYM and NC with biofertilizers was at par with P (22.76 and 27.00 kg ha^{-1}) and K (253.92 and 260.40 kg ha^{-1}) uptake during 2017 and 2018, respectively. This 50% RDN each through FYM and VC treatments recorded 7.64 and 4.62 per cent, 32.47 and 30.31 per cent, 6.49 and 5.46 per cent higher N, P and K uptake as compared to 100% RDN applied through FYM treatment during the year 2017 and 2018, respectively.
The beneficial effect of organic nutrient sources on uptake of N, P and K may be due to release of more nutrients from the decomposition of organic matter from FYM, vermicompost and neem cake incorporated in the soil and higher growth and yield attributing characters might have helped in increase of uptake of N, P and K by crop of brinjal. The better response to FYM and VC may be ascribed by lower C: N ratio leading to increased nutrient availability in soil. These results are in confirmatory with those reported by Dhonde *et al.* (2019) [7].
The interaction between non-chemical weed control modules and organic nutrient sources on uptake of N, P and K by brinjal was found to be non-significant during both the years of experimentation.

Effect of non-chemical weed control modules on soil available nutrients (kg ha^{-1})

The soil available nitrogen, phosphorus and potassium as influenced by different non-chemical weed control modules and organic nutrient sources at 120 DAT are presented in Table 2. The mean soil available nitrogen, phosphorus and potassium were 208.76, 25.71 and 438.67 kg ha^{-1} during 2017 and 209.57, 27.38 and 440.95 kg ha^{-1} during 2018, respectively.
The weed free treatment registered significantly higher value of soil available nutrients like N, P and K than rest of the treatments, however, it was at par with hoeing and pulling of weeds during both the years of experimentation. In weedy check recorded significantly minimum soil available nutrients like N, P and K than rest of the treatments during both the years of experimentation. These results were in conformity with Banjare *et al.* (2013) [4].

Effect of organic nutrient sources on soil available nutrients (kg ha^{-1})

The soil available nutrients after harvest of brinjal were influenced significantly due to different organic nutrient sources during both the years are presented in Table 2. Among the organic nutrient sources crop supplied with 50% RDN each through FYM and VC with biofertilizers recorded significantly higher value of N, P and K, while, it was at par with organic treatments 50% RDN each through FYM and NC with biofertilizers both the year of experimentation. The effect of FYM and VC might have attributed to the mineralization of N in soil and due to high enzyme activity in soil amended with organic might have increased the transformation of nutrients to available form. This might be attributed to the increased population of beneficial micro-organisms like N-fixers, P-solublizers and also higher enzyme activity in soil, the increase in available nitrogen due to application of organic manures might be attributed to the greater multiplication of soil microbes by application of nitrogen through organic nutrient sources. These organics during mineralization convert organically bound nitrogen to inorganic form resulting in higher available nitrogen in soil and the release of organic acids during microbial

decomposition of organic matter which might have helped in the solubility of native phosphates, thus increasing the available phosphorous content in soil (Jagtap *et al.*, 2007) [11]. In addition, the organic anions compete with phosphate ions for the binding sites
on the soil particles. The complex organic anions chelate Al^{3+}, Fe^{3+} and Ca^{2+} and thus decrease the phosphate precipitating power of these cations and thereby increase the phosphorous availability (Hangarge *et al.*, 2002) [8]. Similar results were also reported by Sharma *et al.* (2000) [15]. The build-up of available potassium in soil was due to the beneficial effect of organic manures in releasing potassium due to the interaction of organic matter with clay and direct addition of potassium to the available pool of soil. Similar beneficial effects of organic manures on available potassium content of soil was reported by Datt *et al.* (2003) [6]. The interaction between non-chemical weed control modules and organic nutrient sources was found non-significant in respect of soil available nitrogen, phosphorus and potassium after harvest brinjal during both the years of experiment.

Effect of non-chemical weed control modules on soil micronutrients

The mean available S kg ha^{-1}, DTPA- micronutrient (mg g^{-1}) *viz.* Cu, Fe, Mn, Zn was 35.03 and 35.18 kg ha^{-1}, 1.62 and 1.78 mg g^{-1}, 8.05 and 8.28 mg g^{-1}, 10.94 and 11.38 mg g^{-1}, 1.13 and 1.22 mg g^{-1} during 2017 and 2018, respectively presented in the Table 3 and 4. The available S kg ha^{-1}, DTPA- micronutrient (mg g^{-1}) *viz.* Cu, Fe, Mn, Zn after harvest of brinjal crop was not influenced significantly due to different non-chemical weed control modules during both the years of experimentation. However numerically more depletion of sulphur and DTPA- micronutrients *viz.*, Cu, Fe, Mn, Zn was observed in weeds check treatment than rest of the treatment, whereas minimum depletion was noticed *gliricidia* leaf mulching @ 5 ha^{-1} and mulch-soybean straw @ 5 t ha^{-1}. These might be due to weed are depletes more nutrients than the weed free environment. Similar results were also reported by Jagtap *et al.* (2007) [11].

Effect of organic nutrient sources on soil micronutrients

The available S kg ha^{-1}, DTPA-micronutrient (mg g^{-1}) *viz.* Cu, Fe, Mn, Zn after harvest of brinjal crop was not influenced significantly due to different organic nutrient sources during both the years presented in the Table 3 and 4. However numerically higher available sulphur and DTPA-micronutrients *viz.*, Cu, Fe, Mn, Zn after harvest of brinjal crop was recorded organic nutrient sources supplied with 50% RDN each through FYM and VC with biofertilizers during both the years of experimentation.
The higher availability of micronutrients namely Cu, Fe, Mn and Zn in this treatment might be attributed to higher content of these micronutrients, presence of higher microbial and enzymatic activity in FYM and vermicompost and this might have stimulated the root growth resulted in higher available of micronutrients in brinjal. These results were in accordance with those reported by Thakur *et al.* (2011), who observed in soybean-wheat sequence with the application of vermicompost. The increased availability of Zn with the application of FYM might be due to release of micronutrients in readily available forms to soil. The increase in available Fe upon addition of organic matter like FYM, vermicompost and neem cake might be due to intensified microbial and chemical reduction of Fe^{+++} and pH of the soil and also formation of stable complexes with organic ligands. This might have decreased the susceptibility of Fe to adsorption, fixation or precipitation reaction in soil resulting in greater availability of Fe. The increase in available micronutrients status of soil in organically treated plots might be due to direct addition of organic nutrient sources to soil and release of chelating agents which might have prevented micronutrients from precipitation, oxidation and leaching. The increase in copper and manganese in soil with organic manures might be due to mineralization and release of native copper and manganese. Addition of organics like FYM and vermicompost might be due to intensified microbial and chemical reduction of Fe^{3+} and also formation of stable complexes with organic ligands which might have decreased, fixation or precipitation reaction in soil resulting in greater availability of iron. Similarly, increased availability of zinc was observed in the treatment receiving FYM which might be due to release of available forms of zinc in soil. Zinc forms relatively stable chelates with organic ligand, which decrease susceptibility of zinc to adsorption, fixation and precipitation. The incorporation of organic manures might have resulted in the formation of such organic chelates of higher stability. These results are in confirmatory with those reported by Hasan *et al.* (2013) [9] and Azarmi *et al.* (2008) [3].

Effect of non-chemical weed control modules on nutrient balance

At the end of the two seasons the nutrient balance during both the years of experimentation was worked out with the consideration of inherent soil fertility in respect of soil available N, P and K before commencement of the experimentation. Nutrient added through different organic inputs into the soil in different seasons and left over nutrient in the soil at the end of the first and second year of experimentation. The nutrient balance in respect of N, P and K as influenced by non-chemical weed control modules and organic nutrient sources are presented in Table 5 and are not subjected to statistical analysis.
Among the non-chemical weed control modules, highest balance of N, P and K was observed under weed free treatment followed by hoeing and pulling of weeds (237.00 kg ha^{-1}) and (233.09 kg ha^{-1}), (37.30) and (34.69) and (476.06), (470.15), respectively after the second season of crop cycles.

Effect of organic nutrient sources on nutrient balance

Budgeting of nutrients under the treatment of organic nutrient sources showed highest balance of N P and K and was observed after second year crop cycle are presented in Table 5. The N, P and K was highest balance (223.13 kg ha^{-1}), (221.74 kg) and (30.74), (30.21) and (453.84). (446.97) recorded with application of 50% RDN each through FYM and VC with biofertilizers followed by application of 50% RDN each through FYM and NC with biofertilizers, respectively. Maximum balance of nutrients under 50% RDN through FYM and VC with biofertilizers might be due to conjunctive use of organic sources and biofertilizers which helps to improve soil health by adding nutrients to soil, which further useful for next season crop instead of crop uptake.

Conclusion

Based on two year experimentation, it could be concluded that cultivation of *kharif* brinjal with non-chemical weed control modules of keeping the crop weed free up to 80 days after transplanting by adapting five hand weeding (at an interval of 15 days) or four mechanical (hoeing) inter cultivation and pulling of weeds between the rows (20 days interval from 20 to 80 days after transplanting) and application of 50 per cent nitrogen (50 N kg ha^{-1}) each through farm yard manure and vermicompost with biofertilizers (*Azospirillum* and *PSB*) along with organic plant protection measures found suitable organic package for higher productivity, fruit quality and sustaining soil health.

Table 1: Nutrient uptake (kg ha^{-1}) by brinjal crop as influenced by non-chemical weed control modules and organic nutrient sources at harvest

Treatments		Nutrient uptake by brinjal (kg ha^{-1})					
		Nitrogen		Phosphorus		Potassium	
		2017	2018	2017	2018	2017	2018
A.	**Non-chemical weed control modules**						
W_1:	GLM @ 5 t ha^{-1}	114.17	119.45	20.96	24.95	262.06	267.33
W_2:	Mulch (soybean straw) @ 5 t ha^{-1}	115.26	121.13	21.25	25.14	263.73	269.62
W_3:	Hoeing and pulling of weeds	121.46	130.13	23.92	27.67	273.40	277.14
W_4:	Weedy check	70.09	76.94	15.52	18.05	177.83	184.91
W_5:	Weed free	125.43	134.85	25.71	28.67	278.72	282.49
	S.Em (±)	1.23	1.52	0.61	0.63	1.16	1.67
	CD @ 5%	4.01	4.96	1.99	2.06	3.80	5.44
B.	**Organic nutrient sources**						
O_1:	100% RDN (FYM) + BF	107.06	115.24	18.57	22.00	243.94	250.49
O_2:	100% RDN (VC) +BF	108.41	115.74	20.92	23.93	249.47	253.68
O_3:	100% RDN (NC) +BF	107.39	115.79	21.67	25.33	249.95	255.99
O_4:	50:50% RDN (FYM+VC) +BF	115.25	120.57	24.60	28.67	259.79	264.17
O_5:	50:50% RDN (FYM+NC) +BF	111.08	118.53	22.76	27.00	253.92	260.40
O_6:	50:50% RDN (VC+NC) +BF	108.01	114.52	20.77	23.76	249.47	254.54
O_7:	1/3 RDN (FYM + VC + NC) +BF	107.76	115.11	21.03	23.57	251.49	254.83
	S.Em (±)	0.93	0.48	0.68	0.79	2.12	1.82
	CD @ 5%	2.88	1.50	2.10	2.44	6.54	5.60
C.	**Interaction (A x B)**						
	Between two organic nutrient sources means at same level of non-chemical weed control modules means						
	S.Em (±)	2.65	2.60	1.54	1.88	3.19	3.44
	CD @ 5%	NS	NS	NS	NS	NS	NS
	Between two non-chemical weed control modules means at same level of organic nutrient sources means						
	S.Em (±)	2.45	2.09	1.53	1.88	3.57	3.43
	CD @ 5%	NS	NS	NS	NS	NS	NS
	Mean	109.28	116.50	21.47	24.90	251.15	256.30

Table 2: Soil available nutrients as influenced by non-chemical weed control modules and organic nutrient sources

Treatments		Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})	
		2017	2018	2017	2018	2017	2018
A.	**Non-chemical weed control modules**						
W_1:	GLM @ 5 t ha^{-1}	196.43	198.38	20.48	21.71	425.19	426.57
W_2:	Mulch (soybean straw) @ 5 t ha^{-1}	200.52	203.43	22.24	24.05	432.10	433.52
W_3:	Hoeing and pulling of weeds	206.52	207.90	24.62	25.86	436.19	437.52
W_4:	Weedy check	186.90	189.14	16.43	17.19	386.14	387.57
W_5:	Weed free	208.76	209.57	25.71	27.38	438.67	440.95
	S.Em (±)	0.75	0.69	0.38	0.48	1.37	1.34
	CD @ 5%	2.47	2.25	1.26	1.59	4.48	4.37
B.	**Organic nutrient sources**						
O_1:	100% RDN (FYM) + BF	199.87	201.33	21.73	23.00	423.07	423.80
O_2:	100% RDN (VC) +BF	199.53	201.67	21.73	22.80	423.00	423.93
O_3:	100% RDN (NC) +BF	199.27	201.73	21.80	22.87	423.33	424.07
O_4:	50:50% RDN (FYM+VC) +BF	201.13	203.33	22.40	24.13	427.93	429.47
O_5:	50:50% RDN (FYM+NC) +BF	200.80	202.27	22.20	23.80	424.53	426.00
O_6:	50:50% RDN (VC+NC) +BF	199.73	201.33	21.73	23.07	422.07	424.00
O_7:	1/3 RDN (FYM + VC + NC) +BF	198.47	200.13	21.67	23.00	421.67	424.40
	S.Em (±)	0.37	0.35	0.09	0.13	1.11	1.14
	CD @ 5%	1.16	1.08	0.30	0.43	3.43	3.52
C.	**Interaction (A x B)**						
	Between two organic nutrient sources means at same level of non-chemical weed control modules means						
	S.Em (±)	1.12	1.17	0.55	0.58	3.11	2.79
	CD @ 5%	NS	NS	NS	NS	NS	NS
	Between two non-chemical weed control modules means at same level of organic nutrient sources means						
	S.Em (±)	0.88	0.98	0.39	0.34	2.91	2.62
	CD @ 5%	NS	NS	NS	NS	NS	NS
	Mean	199.83	201.69	21.90	23.24	423.66	425.23
	Initial value	181.33		15.79		403.56	

Table 3: DTPA- micronutrients of soil as influenced by non-chemical weed control modules and organic nutrient sources (2017)

Treatments		DTPA- micronutrients (mg g^{-1} of soil)				
		Available S (kg ha^{-1})	Cu	Fe	Mn	Zn
A.	**Non-chemical weed control modules**					
W_1:	GLM @ 5 t ha^{-1}	35.06	1.57	8.21	11.24	1.10
W_2:	Mulch (soybean straw) @ 5 t ha^{-1}	35.10	1.75	8.12	10.83	1.12
W_3:	Hoeing and pulling of weeds	35.04	1.88	8.00	11.02	1.16
W_4:	Weedy check	35.13	1.05	7.56	10.52	1.07
W_5:	Weed free	34.86	1.92	8.37	11.06	1.21
	S.Em (±)	0.08	0.22	0.21	0.45	0.03
	CD @ 5%	NS	NS	NS	NS	NS
B.	**Organic nutrient sources**					
O_1:	100% RDN (FYM) + BF	34.98	1.56	8.09	10.82	1.11
O_2:	100% RDN (VC) +BF	35.00	1.61	8.03	10.82	1.11
O_3:	100% RDN (NC) +BF	35.07	1.59	8.20	10.86	1.10
O_4:	50:50% RDN (FYM+VC) +BF	35.08	1.71	8.21	11.11	1.23
O_5:	50:50% RDN (FYM+NC) +BF	35.08	1.63	7.91	10.82	1.12
O_6:	50:50% RDN (VC+NC) +BF	35.02	1.58	7.94	10.94	1.11
O_7:	1/3 RDN (FYM + VC + NC) +BF	35.01	1.70	7.99	11.18	1.13
	S.Em (±)	0.04	0.14	0.08	0.11	0.04
	CD @ 5%	NS	NS	NS	NS	NS
C.	**Interaction (A x B)**					
	Between two organic nutrient sources means at same level of non-chemical weed control modules means					
	S.Em (±)	0.15	0.33	0.30	0.63	0.07
	CD @ 5%	NS	NS	NS	NS	NS
	Between two non-chemical weed control modules means at same level of organic nutrient sources means					
	S.Em (±)	0.13	0.26	0.22	0.44	0.08
	CD @ 5%	NS	NS	NS	NS	NS
	Mean	35.03	1.62	8.05	10.44	1.13
	Initial value	34.49	1.01	7.30	10.02	1.03

Table 4: DTPA- micronutrients of soil as influenced by non-chemical weed control modules and organic nutrient sources (2018)

Treatments		DTPA- micronutrients (mg g^{-1} of soil)				
		Available S (kg ha^{-1})	Cu	Fe	Mn	Zn
A.	**Non-chemical weed control modules**					
W_1:	GLM @ 5 t ha^{-1}	35.24	1.67	8.36	11.63	1.22
W_2:	Mulch (soybean straw) @ 5 t ha^{-1}	35.20	1.80	8.30	11.28	1.21
W_3:	Hoeing and pulling of weeds	35.18	2.07	8.24	11.54	1.29
W_4:	Weedy check	35.28	1.18	7.78	10.81	1.15
W_5:	Weed free	34.98	2.18	8.70	11.63	1.25
	S.Em (±)	0.13	0.23	0.20	0.21	0.08
	CD @ 5%	NS	NS	NS	NS	NS
B.	**Organic nutrient sources**					
O_1:	100% RDN (FYM) + BF	35.15	1.84	8.35	11.23	1.23
O_2:	100% RDN (VC) +BF	35.16	1.75	8.25	11.22	1.21
O_3:	100% RDN (NC) +BF	35.20	1.78	8.37	11.28	1.19
O_4:	50:50% RDN (FYM+VC) +BF	35.20	1.74	8.34	11.70	1.34
O_5:	50:50% RDN (FYM+NC) +BF	35.22	1.83	8.17	11.23	1.22
O_6:	50:50% RDN (VC+NC) +BF	35.15	1.75	8.21	11.39	1.18
O_7:	1/3 RDN (FYM + VC + NC) +BF	35.15	1.78	8.24	11.61	1.20
	S.Em (±)	0.04	0.11	0.08	0.12	0.05
	CD @ 5%	NS	NS	NS	NS	NS
C.	**Interaction (A x B)**					
	Between two organic nutrient sources means at same level of non-chemical weed control modules means					
	S.Em (±)	0.22	0.35	0.35	0.43	0.11
	CD @ 5%	NS	NS	NS	NS	NS
	Between two non-chemical weed control modules means at same level of organic nutrient sources means					
	S.Em (±)	0.18	0.27	0.30	0.38	0.09
	CD @ 5%	NS	NS	NS	NS	NS
	Mean	35.18	1.78	8.28	11.38	1.22
	Initial value	34.85	1.12	7.69	10.59	1.09

Table 5: Nutrient balance sheet as influenced by different treatment after harvest of brinjal crop (2017-2019)

Treatments		Initial nutrients (kg ha^{-1})			Nutrients applied to crop (kg ha^{-1})			Nutrient uptake by crop (kg ha^{-1})			Soil available nutrients after harvest (kg ha^{-1})			Nutrient balance (kg ha^{-1})		
		(A)			(B)			(C)			(D)			(D-A)		
		N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
A.	Non-chemical weed control modules															
W_1:	GLM @ 5 t ha^{-1}	200.00	201.98	159.88	381.33	217.77	563.44	274.77	75.26	549.11	394.81	42.19	851.76	213.48	26.4	448.2
W_2:	Mulch (soybean straw) @ 5 t ha^{-1}	200.00	201.98	159.88	381.33	217.77	563.44	278.17	78.73	552.25	403.95	46.29	865.62	222.62	30.5	462.06
W_3:	Hoeing and pulling of weeds	200.00	201.98	159.88	381.33	217.77	563.44	267.58	82.2	568.68	414.42	50.48	873.71	233.09	34.69	470.15
W_4:	Weedy check	200.00	201.98	159.88	381.33	217.77	563.44	217.4	67.25	384.29	376.04	33.62	773.71	194.71	17.83	370.15
W_5:	Weed free	200.00	201.98	159.88	381.33	217.77	563.44	264.43	79.6	578.86	418.33	53.09	879.62	237.0	37.30	476.06
B.	Organic nutrient sources															
O_1:	100% RDN (FYM) + BF	200.00	201.98	159.88	381.33	217.77	563.44	266.58	69.28	513.15	401.2	44.73	846.87	219.87	28.94	443.31
O_2:	100% RDN (VC) +BF	200.00	201.98	159.88	381.33	217.77	563.44	256.28	74.33	521.36	401.2	44.53	846.93	219.87	28.74	443.37
O_3:	100% RDN (NC) +BF	200.00	201.98	159.88	381.33	217.77	563.44	254.93	76.75	524.42	401	44.67	847.4	219.67	28.88	443.84
O_4:	50:50% RDN (FYM+VC) +BF	200.00	201.98	159.88	381.33	217.77	563.44	267.45	86.73	545.12	404.46	46.53	857.4	223.13	30.74	453.84
O_5:	50:50% RDN (FYM+NC) +BF	200.00	201.98	159.88	381.33	217.77	563.44	261.91	80.63	534.06	403.07	46.00	850.53	221.74	30.21	446.97
O_6:	50:50% RDN (VC+NC) +BF	200.00	201.98	159.88	381.33	217.77	563.44	255.29	74.12	523.02	401.06	44.8	846.07	219.73	29.01	442.51
O_7:	1/3 RDN (FYM + VC + NC) +BF	200.00	201.98	159.88	381.33	217.77	563.44	260.83	74.42	525.33	231.47	44.67	846.07	50.13	28.88	442.51

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