International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 21, 2018, pp.-7432-7435.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EFFECT OF ORGANIC AMENDMENTS WITH INORGANIC FERTILIZERS THROUGH FERTIGATION ON GROWTH, YIELD OF WATERMELON (*Citrullus lanatus* Thunb.) AND SOIL FERTILITY OF *THERI* LAND (RED SAND DUNE) IN THOOTHUKUDI DISTRICT OF TAMIL NADU

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Received: October 29, 2018; Revised: November 11, 2018; Accepted: November 12, 2018; Published: November 15, 2018

Abstract: The present investigation was carried out at Thirumaraiyur village, Sattankulam taluk, Thoothukudi district to study the effect of organic amendments with recommended dose of fertilizers on growth and yield of watermelon in Theri soil (red sand dunes) during the year 2017 and 2018. In all there were three factors as organic amendments with 6 treatment combinations for each factor, which were assigned at random in each plot with three replications. The recommended dose of fertilizers in treatments were two levels as 75 and 100 per cent. Among the three factors, the tank silt application @ 100 t ha^{-1} with 100 per cent recommended fertilizer as 200:100:100 kg of NPK ha^{-1} through fertigation at 7 days interval (T5) produced maximum number of branches (10.7), longest vine (362 cm), number of fruits plant^{-1} (2.56), weight of fruit (5.3 kg), fruit yield (68.22 t ha^{-1}), gross return (4,09,320/ha), B:C ratio (2.45), uptake of NPK 41.64, 3.68 and 31.93 kg ha-1, respectively) compared to other treatments. Significant built up of organic carbon (0.66%), available N (253.2 kg ha-^{1}), P (16.2 kg ha^{-1}) and K (218.5 kg ha^{-1}) were registered with the application of tank silt application @ 100 t ha^{-1} with 100 per cent recommended fertilizer as 200:100:100 kg of NPK ha^{-1} through fertigation at 7 days interval.

Keywords: *Watermelon, Theri land, organic amendments, inorganic fertilizers, growth and yield*

Citation: Paramasivan M., *et al*., (2018) Effect of Organic Amendments with Inorganic Fertilizers through Fertigation on Growth, Yield of Watermelon (Citrullus lanatus Thunb.) and Soil Fertility of *Theri* land (Red sand dune) in Thoothukudi district of Tamil Nadu. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 21, pp.- 7432-7435.

Introduction

Watermelon (*Citrullus lanatus* Thunb.) is one of the important vegetable crops grown extensively in India. It is a major tropical crop in south Indian states of Karnataka, Andhra Pradesh and Tamil Nadu. India is the second largest producer of watermelon fruit among the Asian countries accounting 2.48 million tonnes from 1.01 lakh hectare with the productivity of 24.58 t ha^{-1} [1]. In Tamil Nadu, the production is 1.63 lakh tonnes from an area of 6930 ha with the average productivity of 23.52 t ha [2]. *Theri* lands (red sand dunes) are one of the major wastelands in Tirunelveli and Thoothukudi districts of Tamil Nadu. These *Theries* are located (77°49' 44" to 78°28' 22" E and from 8°15'13" to 9°11' 0" N) to an extent of 20,171 ha [3]. Soils have low nutrient status, low water holding capacity, low organic carbon content and are susceptible to high wind erosion [4]. The mean annual rainfall of the study area is between 610 to 700 mm. *Theri* soils (red sand dune) organic amendments like tank silt, FYM, composted coir pith (CCP) etc. improve the physic-chemical properties of soil. Organic amendments and inorganic fertilizers are essential to increase the productivity of crops and fertility of soils. The fertigation technology is the possible way to improve the crop production and soil productivity for profitable farming in constrained *Theri* soil. Fertigation within the rhizosphere matches with the physiological needs of the crop *viz*. root development, vegetative growth, flower and fruit development. Scientific information on fertigation in *Theri* land (red sand dune), especially in watermelon, is very scanty. Present field experiment set up to determine influence of organic amendments combined with inorganic fertilizers through fertigation on growth, fruit yield of watermelon and soil fertility of *Theri* land.

Materials and Methods

The experiment was conducted during kharif – winter seasons of 2016-2017 and 2017-2018 at Thirumaraiyur village, Sattankulam taluk, Thoothukudi district, Tamil Nadu. The sand dune ecosystem formed in isomegathermic and ustic regime from geogenic sand deposit under a semi arid climate. Soil at the experimental site was red sandy, with organic carbon 0.12%, electrical conductivity 0.13 dS/m, neutral pH (6.66), low available N (93.7 kg ha^{-1}), low available P (8.2 kg ha^{-1}) and low available K (88.5 kg ha^{-1}). Seeds of watermelon F1 hybrid Suprit were sown in rows of 2m width, with 60 cm plant-to-plant spacing, during the first week of November in both years. The experiment was laid out in Factorial Randomized Block Design (FRBD) with six treatments and three replications. Factor as three organic amendments *viz*., tank silt @ 100 t ha^{-1}, composted coir pith @ 12.5 t ha^{-1} and farm yard manure @ 20 t ha^{-1} were applied as uniform basal doses before sowing. The treatments were T1- 75 % recommended dose of fertilizers (RDF) (150:75:75 kg of NPK ha^{-1}) through soil application; T2- 100 % recommended dose of fertilizers (RDF) (200:100:100 kg of NPK ha^{-1}) through soil application; T3- 75 % recommended dose of fertilizers (RDF) (150:75:75 kg of NPK ha^{-1}) through fertigation at 7 days interval; T4- 75 % recommended dose of fertilizers (RDF) (150:75:75 kg of NPK ha-1) through fertigation at 15 days interval; T5- 100 % recommended dose of fertilizers (RDF) (200:100:100 kg of NPK ha^{-1}) through fertigation at 7 days interval; T6- 100 % recommended dose of fertilizers (RDF) (200:100:100 kg of NPK ha^{-1}) through fertigation at 15 days interval. Conventional fertilizers used in the experiment were urea, single super phosphate, di-ammonium phosphate and muriate of potash; whereas, 19 each of N, P2O5, K2O,

Table-1 Effect of organic amendment with inorganic fertilizers on growth and yield of hybrid watermelon

Treatments	No. of branches plant^{-1}	Vine length(cm)	No. of fruits plant^{-1}	Average fruit wt. (kg)	Fruit yield (t ha^{-1})	Cost of cultivation(₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	Benefit: cost ratio
Tank silt @ 100 t ha^{-1}									
T_1 - 75 % RDF (Soil application)	7.3	274	1.83	4.43	40.66	72,820	1,62,640	89,820	1.23
T_2 -100 % RDF (Soil application)	8.0	305	2.03	4.63	47.14	83,750	1,88,560	1,04,810	1.25
T_3 -75 % RDE at 7 days interval (Fertigation)	9.3	351	2.40	5.17	62.23	1,12,820	3,73,380	2,60,560	2.31
T_4 -75 % RDF at 15 days interval (Fertigation)	8.4	319	2.20	4.87	53.74	1,07,820	3,22,440	2,14,620	1.99
T_5 -100 % RDF at 7 days interval (Fertigation)	10.7	362	2.56	5.30	68.22	1,18,750	4,09,320	2,90,570	2.45
T_6 -100 % RDF at 15 days interval (Fertigation)	8.7	327	2.30	5.00	57.68	1,13,750	3,46,080	2,32,330	2.04
SEd	3.35	0.08	0.032	0.084	1.68	-	-	-	-
CD (P=0.05)	7.46	0.19	0.071	0.187	3.74	-	-	-	-
Composted coir pith (CCP) @12.5 t ha^{-1}									
T_1 - 75 % RDF (Soil application)	6.7	270	1.77	4.17	37.06	92,820	1,48,200	55,380	1.60
T_2 -100 % RDF (Soil application)	7.3	298	2.03	4.40	44.80	1,03,750	1,79,200	75,450	1.73
T_3 -75 % RDE at 7 days interval (Fertigation)	9.0	338	2.27	5.00	56.93	1,32,820	3,41,580	2,08,760	2.57
T_4 -75 % RDF at 15 days interval (Fertigation)	7.7	308	2.10	4.67	49.19	1,27,820	2,95,140	1,67,320	2.31
T_5 -100 % RDF at 7 days interval (Fertigation)	10.3	351	2.33	5.27	61.59	1,38,750	3,69,540	2,30,790	2.66
T_6 -100 % RDF at 15 days interval (Fertigation)	8.3	318	2.17	4.83	52.03	1,33,750	3,12,180	1,78,430	2.33
SEd	0.09	3.17	0.03	0.09	1.15	-	-	-	-
CD (P=0.05)	0.21	7.05	0.06	0.20	2.56	-	-	-	-
Farm yard manure (FYM) @ 20 t ha^{-1}									
T_1 - 75 % RDF (Soil application)	6.2	259	1.67	4.27	35.76	82,820	1,43,040	60,220	1.73
T_2 -100 % RDF (Soil application)	6.7	287	1.93	4.53	43.85	93,750	1,75,400	81,650	1.87
T_3 -75 % RDE at 7 days interval (Fertigation)	8.6	328	2.20	5.00	55.18	1,22,820	3,31,080	2,08,260	2.69
T_4 -75 % RDF at 15 days interval (Fertigation)	7.3	301	2.00	4.83	48.45	1,17,820	2,90,700	1,72,880	2.47
T_5 -100 % RDF at 7 days interval (Fertigation)	9.4	332	2.26	5.17	58.61	1,28,750	3,51,660	2,22,910	2.73
T_6 -100 % RDF at 15 days interval (Fertigation)	8.3	308	2.06	4.93	51.66	1,23,750	3,09,960	1,86,210	2.50
SEd	0.15	2.99	0.04	0.06	0.79	-	-	-	-
CD (P=0.05)	0.34	6.66	0.09	0.12	1.78	-	-	-	-

Table-2 Effect of organic amendment with inorganic fertilizers on nutrient uptake of hybrid watermelon and soil fertility

Treatments	Nutrient uptake (kg/ha)			Organic carbon (%)	Available nutrients (kg/ha)		
	N	P	K		N	P	K
Tank silt @ 100 t ha^{-1}							
T_1 - 75 % RDF (Soil application)	22.94	1.55	15.52	0.42	146.8	10.6	165.3
T_2 -100 % RDF (Soil application)	27.51	2.02	20.92	0.47	175.3	12.5	182.8
T_3 -75 % RDE at 7 days interval (Fertigation)	39.40	3.16	29.85	0.56	212.4	14.8	202.6
T_4 -75 % RDF at 15 days interval (Fertigation)	31.82	2.46	23.62	0.49	198.7	12.7	193.5
T_5 -100 % RDF at 7 days interval (Fertigation)	41.64	3.68	31.93	0.66	253.2	16.2	218.5
T_6 -100 % RDF at 15 days interval (Fertigation)	35.03	2.72	23.77	0.52	193.4	13.6	196.2
SEd	4.16	0.35	2.18	0.01	4.16	0.35	2.18
CD (P=0.05)	9.27	0.78	4.86	0.02	9.27	0.78	4.86
Composted coir pith (CCP) @12.5 t ha^{-1}							
T_1 - 75 % RDF (Soil application)	19.79	1.41	10.91	0.41	140.5	9.5	142.5
T_2 -100 % RDF (Soil application)	26.35	1.93	17.69	0.44	155.7	11.8	168.3
T_3 -75 % RDE at 7 days interval (Fertigation)	38.37	3.13	29.11	0.52	222.4	14.3	183.4
T_4 -75 % RDF at 15 days interval (Fertigation)	30.46	2.13	19.96	0.45	183.6	12.5	171.5
T_5 -100 % RDF at 7 days interval (Fertigation)	40.92	3.72	30.00	0.57	242.8	17.1	202.5
T_6 -100 % RDF at 15 days interval (Fertigation)	34.25	2.52	23.49	0.47	188.8	12.3	176.6
SEd	1.29	0.24	3.87	0.01	1.29	0.24	3.87
CD (P=0.05)	2.87	0.54	8.62	0.03	2.87	0.54	8.62
Farm yard manure (FYM) @ 20 t ha^{-1}							
T_1 - 75 % RDF (Soil application)	18.66	1.27	9.54	0.38	132.3	9.2	140.6
T_2 -100 % RDF (Soil application)	23.36	1.68	14.71	0.41	143.5	11.7	158.2
T_3 -75 % RDE at 7 days interval (Fertigation)	32.69	2.83	25.75	0.52	218.4	13.6	173.5
T_4 -75 % RDF at 15 days interval (Fertigation)	24.17	1.66	18.23	0.44	165.5	12.2	161.7
T_5 -100 % RDF at 7 days interval (Fertigation)	37.93	3.23	29.55	0.55	230.3	15.8	189.6
T_6 -100 % RDF at 15 days interval (Fertigation)	25.97	2.14	19.03	0.46	181.7	12.8	168.4
SEd	1.38	0.26	2.17	0.01	1.38	0.26	2.17
CD (P=0.05)	3.08	0.58	4.83	0.03	3.08	0.58	4.83

KNO_3 and Ca $(NO_3)2$ formed the source of water-soluble fertilizer. Recommended dose of fertilizer in the present study comprised 200 kg N, 100 kg P_2O_5 and 100 kg K2O per hectare. Fertilizer was applied at 7 and 15 days intervals through fertigation treatments. Soil treatments received the entire P_2O_5 and K_2O at sowing and N in two splits-one at sowing and the other 30 days later. Irrigation was given through drippers to all the treatments. Growth observations were taken 60 days after sowing. All agronomic and plant protection measures were adopted as per the guide lines of crop production guide for Tamil Nadu [5]. The crop was harvested at 90 to 100 days after sowing, at fruit maturity as indicated by a dull sound of the fruit, or, when the fruit tendril turned to straw colour, or when the fruit base turned creamy-yellow in colour. The nutrient content and uptake by plants were analysed through prescribed laboratory procedures. Soil samples were analysed for organic carbon following [6], alkaline permanganate oxidizable N as described by [7], 0.5 M $NaHCO_3$- extractable P [8] and available potassium by flame photometry with extracting 1 N NH_4OAc [9]. Observations on crop growth, yield, yield parameters and quality were recorded and statistically analyzed as per [10]. Economics of water melon cultivation as influenced by chemical fertilizer, drip fertigation and management practices were calculated by considering the prevailing market price of fruit and inputs used.

Results and discussion

Effect of tank silt

Growth attributes

The growth and yield attributes of watermelon *viz*., number of branches, vine length, number of fruits and fruit weight were significantly influenced by different organic amendments with recommended dose of NPK as 200:100:100 kg ha^{-1} through fertigation (Table 1). Significantly maximum number of branches (10.7), longest vine (362 cm), maximum number of fruits per plant (2.56), maximum weight of fruit (5.3 kg) and maximum fruit yield (68.22 t/ha) were obtained in treatment applied with tank silt @ 100 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7 days interval (T5) followed by tank silt @ 100 t ha^{-1} with 75 per cent NPK through fertigation at 7 days interval (T3) with the number of fruit as 9.3, longer vine (351 cm), higher number of fruits per plant (2.40), weight of fruit (5.17 kg) and higher fruit yield (62.23 t ha^{-1}), however, among the two levels of NPK without fertigation the minimum number of branches (7.3), shortest vein length (274 cm), minimum number of fruits per plant (1.83), lowest fruit weight (4.43 kg) and minimum fruit yield (40.66 t ha^{-1}) were found in treatment applied with tank silt @ 100 t ha^{-1} with 75 per cent NPK ha^{-1} through soil application (T1). The present finding was supported by [11]. The uptake of N, P and K in watermelon was also significantly influenced by the application of tank silt @ 100 t/ha with 100 per cent NPK through fertigation at 7 days interval (T5). The highest values of N, P and K uptake (41.64, 3.68 and 31.93 kg ha^{-1}, respectively) by watermelon was recorded with the application of tank silt @ 100 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7 days interval (T5) followed by tank silt @ 100 t/ha with 75 per cent NPK as 150:75:75 kg ha^{-1} through fertigation at 7 days interval (T3) with the value of 39.4, 3.16 and 29.85 kg ha^{-1}, respectively (Table 2). This could be ascribed to the increase in the available N, P and K contents in soil resulting from the increasing availability of nutrients which ultimately increased nutrient content in the plant tissue and also greater biomass production at higher rate of fertilizer application. Since the uptake of nutrient is a function of dry matter and nutrient content, the increased growth and yield attributes together with higher NPK content resulted in greater uptake of these elements. The result confirms the findings of [12] and [13].

Effect of composted coir pith (CCP)

The composted coir pith (CCP) with 100 per cent NPK was showed the similar trend as that of tank silt amendment (Table 1). Significantly maximum number of branches (10.3), longest vine (351 cm), maximum number of fruits $plant^{-1}$ (2.33), weight of fruit (5.27 kg) and maximum fruit yield (61.59 t ha^{-1}) were obtained in treatment applied with composted coir pith @ 12.5 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7 days interval (T5) followed by composted coir pith @ 12.5 t ha^{-1} with 75 per cent NPK through fertigation at 7 days interval (T3) with the value of 9.0, longer vine (338 cm), higher number of fruits $plant^{-1}$ (2.27), weight of fruit (5.00 kg) and higher fruit yield (56.93 t ha^{-1}). The two levels of NPK without fertigation, the minimum number of branches (76.7), shortest vein length (270 cm), minimum number of fruits per plant (1.77), lowest fruit weight (4.17 kg) and minimum fruit yield (37.06 t ha^{-1}) were found in treatment applied with CCP @ 12.5 t ha^{-1} with 75 per cent NPK ha^{-1} through soil application (T1). The present finding was supported by [14]. The highest values of N, P and K uptake (40.92, 3.72 and 30.00 kg ha^{-1}, respectively) by watermelon was recorded with the application of CCP @ 12.5 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7 days interval (T5) followed by CCP @ 12.5 t ha^{-1} with 75 per cent NPK as 150:75:75 kg ha^{-1} through fertigation at 7 days interval (T3) with the value of 38.37, 3.13 and 29.11 kg ha^{-1}, respectively (Table 2). The result confirms the findings of [12] and [13]. They reported that the increase in nutrient uptake in watermelon might be due to fact that inorganic fertilizer through fertigation increased more metabolites transported for growth and yield.

Effect of farm yard manure (FYM)

Among the three amendments, the application of farm yard manure (FYM) @ 20 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7 days interval (T5) also revealed similar trend growth and yield attributes with the maximum branches (9.4), longest vine (332 cm), maximum number of fruits $plant^{-1}$ (2.26), weight of fruit (5.17 kg) and maximum fruit yield (58.61.59 t ha^{-1}). The values of N, P and K uptake (37.93, 3.23 and 29.55 kg ha^{-1}, respectively) by watermelon was recorded for the same treatment. These results agree with the findings of [15] and [16].

Soil fertility

At the end of the experiment, the highest organic carbon (0.66 %), available N, P and K (253.2, 16.2 and 218.5 kg ha^{-1}, respectively) were obtained by the application of tank silt @ 100 t ha^{-1} with 100 per cent NPK through fertigation at 7 days interval (T5). The next superior values of organic carbon (0.56%) and available N,P and K (212.4, 14.8 and 202.6 kg ha^{-1}, respectively) were recorded for the treatment which received tank silt @ 100 t ha^{-1} with 75 per cent NPK as 150:75:75 kg ha^{-1} through fertigation at 15 days interval (T3). The lowest values of organic carbon (0.42%) and available N, P and K (146.8, 10.6 and 165.3 kg ha^{-1}, respectively) were noticed in the treatment with received tank silt @ 100 t ha^{-1} with 75 per cent NPK as 150:75:75 kg ha^{-1} through soil application (T1) (Table 2). The decline in the available N status of the soil might be attributed to the utilization of N, P and K for growth of watermelon. These results agree with the findings of [17] and [18]. Application of CCP @ 12.5t/ha with 100 per cent NPK through fertigation at 7 days interval (T5) exhibited the superior performance on fertility status as organic carbon (0.57 %), available N, P and K (242.8, 17.1 and 202.5 kg ha^{-1}, respectively). Another organic amendment of farm yard manure (FYM) @ 20 t/ha with 100 per cent NPK through fertigation at 7 days interval registered better fertility status as organic carbon (0.55 %), available N, P and K (230.3, 15.8 and 189.6 kg ha^{-1}, respectively). In all factors, the inorganic fertilizer in two levels (75 and 100 per cent) applied directly to the soil recorded the lower values of growth, yield attributes and fertility status of the soil. Similar results were reported earlier by [19] and [20].

Economic

Details on economics and benefit:cost ratio in watermelon F1 hybrid Suprit in relation to various organic amendments with inorganic fertilizers with and without fertigation treatments tested are presented in Table 1. The application of tank silt @ 100 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7 days interval (T5) fetched significantly the highest net returns (2,90,570 and benefit : cost ratio (2.45) over the rest of the treatments (Table 1). The better treatment was application of tank silt @ 100 t/ha with 75 per cent NPK as 150:75:75 kg ha^{-1} through fertigation at 15 days interval (T3), which fetched a net return of 2,60, 560 and benefit : cost ratio of 2.31. The application of CCP@ 12.5 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7days interval recorded the net return of 2,30, 790 and benefit : cost ratio of 1.66 which was higher than the application of FYM @ 20 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7 days interval by fetching the net

return of 2,22, 910 and benefit : cost ratio of 1.73. This might be due to increased higher productivity and lower cost of cultivation. The variation in the cost of cultivation under different treatments were recorded due to variable costs of fertilizers. Fruit yield was the major factor, which caused differences in net return. These results are in close conformity with the findings of [21] and [22].

Conclusion

It can be concluded that application of tank silt @ 100 t ha^{-1} with 100 per cent NPK as 200:100:100 kg ha^{-1} through fertigation at 7 days interval could be recommended for increasing the fruit yield of hybrid watermelon, better net return and sustaining soil fertility in *Theri* land (Red sand dune) of Thoothukudi district of Tamil Nadu.

Application of research: 1, 2 sentences

Research Category: Soil Science and Agricultural Chemistry

Acknowledgement / Funding: Authors are thankful to Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India

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University: Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu
Research project name or number: PhD Thesis

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript

Conflict of Interest: None declared

Sample Collection:

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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