Advances in Crop Science and Technology

Temteme et al., Adv Crop Sci Tech 2017, 5:5
DOI: 10.4172/2329-8863.1000305

Research Article OMICS International

Influence of Type of Planting Material, Plant Density and Method of Planting on the Yield and Quality of Turmeric (*Curcuma domestica* L.) at Tepi Southwestern Ethiopia

Shiferaw Temteme[1], Essubalew Getachew[1*], Behailu Mekonnen[2] and Tesfaye Shimber[3]

[1]*Tepi National Spice Research Center, Tepi, Ethiopia*

[2]*Department of Horticulture and Plant Sciences, Jimma University College of Agriculture and Veterinary Medicine, Jimma, Ethiopia*

[3]*Ethiopian Institute of Agricultural Research, Addis Abeba, Ethiopia*

[*]**Corresponding author:** Essubalew Getachew, Department of Horticulture and Plant Sciences, Jimma University College of Agriculture and Veterinary Medicine, PO Box 307, Jimma, Ethiopia, Tel: +251-91-783-61-08 ; E-mail: g.essu2011@gmail.com

Received date: August 14, 2017; **Accepted date:** August 24, 2017; **Published date:** September 04, 2017

Abstract

A field experiment was conducted at Tepi National Spice Research Center for two consecutive years, to find out optimum planting material, population density and method of planting to enhance turmeric yield and quality at Tepi southwestern Ethiopia. Twenty four treatment combinations consist of 3 levels of planting material (Mother Rhizome, Primary Rhizome and Secondary Rhizome), 4 levels of population density (222,222 plants ha^{-1}, 166,667 plants ha^{-1}, 111, 111 plants ha^{-1} and 83,333 plants ha^{-1}) and two planting methods (Ridged and Flat) were compared. From the two years data mother rhizome planting material, higher population density and ridge planting method showed better yield. Mother rhizome appeared the best planting material for producing highest fresh turmeric yield which is 857.79 g/plant- 67273.27 kg/ha during 2012-2013 and 527.11 g/plant-60695.94 kg/ha during 2013-2014 year. From the two years data we observed that least turmeric fresh yield was obtained from secondary planting materials. Planting density of 222,222 plants/ha produced the highest fresh turmeric yield of 60695.94 kg/ha and 49101.95 kg/ha for the year of 2012-2013 and 2013-2014 respectively. With regard to planting method ridge planting method produced highest fresh rhizome yield of 59409.27 kg/ha for the first year though non-significant result was observed for the second year. Highest oleoresin content of turmeric was produced at mother rhizome planting material even if there was no significance difference between the different spacing. Population density and planting methods did not affect oleoresin content of turmeric. From this study it can be concluded that mother rhizome planting material, higher population density and ridge planting method showed better yield and quality of turmeric at Tepi southwestern Ethiopia.

Keywords: Plant density; Planting materials; Planting methods; Turmeric; Quality and yield

Introduction

Turmeric (*Curcuma domestica* L.) belongs to family *Zingibraceae*. It is valued for its underground orange colored rhizome which is used as natural coloring agent for food, beverages, cosmetics and dye. Curcuminoids the active principles in turmeric rhizome is known to have some medicinal properties and has been used efficiently in the treatment of circulatory problems, liver disease, and dermatological disorders and blood purification [1]. It is well adapted to hot-humid lowland agro ecologies of southwestern Ethiopia and widely cultivated in these areas especially around Tepi and its vicinity, being the potential cash crop next to coffee. Unlike other spice crops, turmeric is exposed either in its dried form and/or as oleoresin or essential oils extract, thereby fetching foreign currency to the country [2].

Turmeric can be grown under diverse tropical conditions with altitudes 1500 m.a.sl with temperature ranging between 20-30°C with annual rainfall of 1500 mm [3]. Well-drained, fertile, and friable soils having sufficient humus, and neutral PH were reported ideal for turmeric [4]. In view of the prevailing favorable soil and climatic conditions in Ethiopia, the country can play a leading role in turmeric production. Albeit, this potential has not been fully utilized the production techniques and poorly understood hence, production have been restricted to homestead gardens.

Planting method is soil management tool which affect plant growth and yield of turmeric [5]. According to Gill et al. [6] type of planting method significantly influenced the growth and yield of turmeric; that plant height, number of leaves/plant, tillers/plant, number and weight of rhizome and fresh rhizome yield was significantly higher in ridge than flat planting method at Ludhiana (Punjab), India.

Optimum plant density of crop varies considerably depending upon climatic conditions of the growing area and fertility status of the soil. Plant distance is an important factor for higher production and gives equal opportunity to the plants for their survival and best use of other inputs. The full yield potential of an individual plant is achieved when sown at wider spacing, whereas yield per unit area are maximum when individual plants are subjected to severe competition [7]. On the other hand Kaur [8] reported non-significant effect of two spacing's (60 × 10 cm and 60 × 15 cm) on growth, yield and quality of turmeric at Ludhiana.

Turmeric is propagated vegetatively using both mothers as well as finger rhizomes. The type and weight of planting materials used affects the vigor of the plant and crop yield per unit area as well as the cost of production [9]. From the investigation of the effect of seed size in turmeric Randhawa and Mishera [10], reported that large sized

rhizome weighing approximately 100 g gave significantly higher yield (61 qha^{-1}) than small sized rhizomes (53.3 qha^{-1}) of 50 g weight. On the other hand; the reports of several works from India, Bangladesh, Brazil, Thailand, Pakistan and Mauritius are rather conflicting and inconclusive. While some workers obtained optimum yield from the use of mother rhizome as planting material [11] others either reported optimum crop yield from finger rhizome [12] or no significant yield difference in the type of seed materials used [13].

In Ethiopia in generally around Tepi particularly some works had also been done and some indicative information is available on the agronomic requirement aspects of the crop, unlike other root and tuber crops clear and complete information on the seed type, population density and seed bed requirements for optimum performance are lacking with respect to turmeric production. Hence, currently turmeric growing farmers are using a mixture of the mother rhizome, primary fingers as well as secondary fingers as planting material. Therefore, the present study is hence planned to evaluate the influence of plant density, planting material and method of planting on yield and quality turmeric at Tepi Southwestern Ethiopia.

Materials and Methods

The field experiment was conducted at of Tepi National Spice Research Center for two years (2012 - 2014) cropping season by using rainfall. The experiment was conducted in Randomized Complete Block Design with three replications. The treatments consisted of two levels planting methods (flat and ridge), four levels of plant densities (222,222 plants ha^{-1}; 166,667 plants ha^{-1}; 111,111 plants ha^{-1} and 83,333 plants ha^{-1}) and three types of planting materials (mother rhizome 25-30 g, primary finger rhizome 15-20 g and secondary finger rhizome 5-10 g).

For plant density of 222,222 plants ha^{-1}; the crop was planted at 60 cm × 7.5 cm in ridge planting method and at 30 cm × 15 cm in flat planting method; for plant density of 166,667 plants ha^{-1} ; the crop was planted at 60 cm × 10 cm in ridge planting method and at 30 cm × 20 cm in flat planting method; for plant density of 111, 111 plants ha^{-1} , the crop was planted at 60 cm × 15 cm in ridge planting method and at 30 cm × 30 cm in flat planting method and in plant density of 83,333 plants ha^{-1}, the crop was planted at 60 cm × 20 cm in ridge planting method and at 30 cm × 40 cm in flat planting method. Turmeric variety Damey was used for the study; rhizomes were planted on field March 30 for both years 2013 and 2014. Every treatment was planted on a 3 m × 5 m plot. All the necessary agronomic and field management practice was applied as per the recommendations. The crop was harvested January, 20 in both years. The mandatory data (yield, and quality) were collected on the representative parameters and was subjected to statistical analysis.

Result and Discussion

There is no a there and two way significant interaction effect among the treatments at P<0.05. Data depicted in Table 1 showed that rhizome weight and rhizome number plant^{-1} (mother rhizome, primary rhizome and secondary rhizome) was significantly higher in ridge planting method than flat planting method according to the two years data. Even though there was no significance difference among the treatment in both years. This result is dissimilar with the work of Kumar and Gill [14], who reported that rhizome growth and yield not affected by planting method. From the two years data we observed that rhizome weight affected by different plant spacing.

Broader plant spacing (83,333 plant^{-1}) produced high rhizome weight (777.69 g/clump and 599.23 g/clump for the year of 2012/2013 and 2013/2014, respectively). Similarly, higher rhizome numbers (65.42/plant and 66.1) was observed in the 2012/2013 and 2013/2014, respectively) (Table 2). In the other hand narrow plant spacing (222,222 plant^{-1}) produced low rhizome weight and number. Increase of planting space increased the weight and number of rhizome per plant by reducing competition for resources between the crops. Due to difference in planting materials rhizome weight had significantly affected and from the result we observed that mother rhizome planting material produced the highest total rhizomes weight of 859.79 g/plant and 527.11 g/plant during 2012/2013 and 2013/2014, respectively. The lowest rhizome weight was produced from secondary rhizome planting material for the two years (Table 1). Planting materials was significantly affected by the number of rhizomes per plant. The highest total numbers of rhizomes 69.18 rhizomes per plant was observed for the first year and 52.97 rhizomes per plant was produced from mother rhizome planting material. Whilst, the lowest total numbers of rhizomes was produced from secondary rhizome planting material. The highest number of primary rhizome was observed from mother rhizome planting material. Whereas, the lowest number of primary rhizome was obtained from the secondary planting material and statistically similar with secondary rhizome number. Similar results were reported by Balwinder and Gill [15].

Treatment	Rhizomes weight per plant (g)					
	2012/2013 2013/2014					
	Mother rhizomes	Primary rhizomes	Secondary rhizomes	Mother rhizomes	Primary rhizomes	Secondary rhizomes
Planting methods						
Ridge	194.5a	390.89a	238.17a	86.586	238.72	133.16
Flat	168.64b	317.03b	158.83b	85.583	206.64	114.83
SEm ±	11.224	25.273	14.148	7.0344	22.427	13.747
LSD (5%)	22.397	50.432	28.233	14.037	44.753	27.431
Planting density (plants ha^{-1})						

2,22,222	162.67c	337.61	169.78b	112.04a	67.13	154.08c
1,66,667	166.94bc	330.78	192.61ab	92.53b	72.65	183.25c
1,11,111	197.06ab	387.94	213ab	72.65c	92.53	237.43b
83,333	199.61a	359.5	218.5a	67.13c	112.04	315.95a
SEm ±	15.666	37.699	23.634	7.9978	7.9978	24.652
LSD (5%)	31.278	75.268	47.186	15.968	15.968	49.219
Planting materials						
Mother rhizome	204.04a	422.04a	231.71a	98.928a	277.64a	150.54a
Primary rhizome	194.25a	378.21a	202.92a	85.815ab	211.41b	116.4b
Secondary rhizome	146.42b	261.63b	160.87b	73.512b	178.98b	105.04b
SEm ±	12.248	26.156	19.233	8.1061	25.255	16.178
LSD (5%)	24.446	52.208	38.388	16.18	50.408	32.291

Table 1: Effect of planting methods, planting density and planting material on rhizome weight of turmeric (2012/2013 and 2013/2014).

The effect of different planting methods on plant height, fresh turmeric yield and oleoresin oil content was non-significant. Ramachandran and Muthuswami [16] reported that different planting methods (Ridge and furrow, flat bed broad ridge method) showed non-significant differences in yield of turmeric. Ridge planting method produced higher tiller numbers than flat planting method. The higher planting density produces the highest planting height from the narrow spacing (222,222 plants ha^{-1}) even if there was no significance difference among the other treatments. Mother rhizome planting material produced the highest plant height as compared to the other planting materials. The highest numbers of tillers were recorded at secondary planting material and at wider spacing (83,333 plants ha^{-1}); this is due to the presence of enough amount of spacing for thriving resources, nutrients. The higher fresh turmeric yield was produced at planting density of 166,667 plants ha^{-1} even if there was no significant difference among others and at of mother rhizome planting material. The difference of oleoresin oil content to different type of planting method, planting density and planting material was non-significant (Table 2).

Number of rhizomes per plant						
Treatments 2012/2013				**2013 /2014**		
Mother Rhizomes		**Primary rhizomes**	**Secondary rhizomes**	**Mother rhizomes**	**Primary rhizomes**	**Secondary rhizomes**
Planting methods						
Ridge	6.20a	21.15a	42.82a	5.59	17.10a	30.82
Flat	5.27b	17.83b	35.28b	5.09	14.48b	28.46
SEm ±	0.22	1.24	2.05	0.3	0.99	2.35
LSD (5%)	0.44	2.47	4.17	0.6	1.99	4.69
Planting density (plants ha^{-1})						
2,22,222	5.42	19.88	36.5	4.70b	12.11c	21.1d
1,66,667	5.58	18.36	39.37	4.67b	13.83c	26.23c
1,11,111	5.93	20.88	39.76	5.68a	16.62b	32.06b
83,333	5.1	18.85	40.58	6.32a	20.61a	39.17a
SEm ±	0.35	1.83	3.18	0.37	1.09	2.46
LSD (5%)	0.69	3.66	6.354	0.739	2.01	4.91

Planting materials						
Mother rhizome	5.48	21.2a	42.5a	6.1116a	16.64	31.57
Primary rhizome	5.77	20.55a	39.97a	5.1625b	15.49	29.53
Secondary rhizome	5.94	16.72b	34.68b	4.7574b	15.25	27.82
SEm ±	0.3	1.49	2.6	0.3403	1.28	2.88
LSD (5%)	0.6	2.97	5.18	0.6792	2.56	5.75

Table 2: Effect of planting methods, planting density and planting material on number of rhizome per plant of turmeric (2012/2013 and 2013/2014).

Increased rhizome yield in mother rhizome planting material might be attributed to better crop growth in terms of higher plant height more leaf area and tiller per plant which intercepted more photosynthetically active radiation and resulted in higher values of yield attributing characters which ultimately contributed towards higher yield of the crop. Differences in performance of different sizes of rhizomes can be relied on the source-sink relationship, as the mother rhizomes constitute a stronger sink than the fingers. Translocation and mobilization of assimilates and nutrients are more in mother rhizome thereby making the mother rhizomes qualitatively and quantitatively superior. Thus, the turmeric plants resulted from mother rhizomes are more vigorous and yield better as compared to finger plant materials (secondary and primary rhizomes). Significantly higher fresh rhizome yield due to mother rhizome plant material was also recorded. This result is similar with Singh et al. [17], Alam et al. [18], Philip [19] and Kumar and Gill [14] recorded significantly higher yield of turmeric. Closer plant spacing produced significantly higher turmeric yield than broader plant spacing (Table 3). Higher fresh turmeric yield was produced from narrow spacing during the two years data though statistically there was no significance difference among the other treatments. Increase in plant population density of turmeric increased the yield of turmeric.

	2012 /2013				**2013/2014**			
Treatments	**Fresh yield (kg/ha)**	**Oleoresin**	**PH (cm)**	**Tillers**	**Fresh yield (kg/ha)**	**Oleoresin**	**PH (cm)**	**Tillers**
Planting method								
Ridge	59409.27	5.93	98.13a	3.49	45750.62	8.27	67.12a	5.05a
Flat	54073.95	5.13	89.34b	3.36	47337.29	8.08	73.84b	3.14b
SEm ±	3263.13	0.17	1.91	0.16	3738.26	0.12	2.13	0.3
LSD	NS	NS	3.82	0.32	NS	NS	4.26	0.59
Planting density ha^{-1}								
2,22,222	60695.94	6.5	94.75	2.89c	49101.95	8.21	70.63	3.88
1,66,667	56981.28	4.78	95.69	3.22bc	46103.95	8.13	67.44	3.72
1,11,111	56177.94	4.75	91.51	3.45b	45766.62	8.24	71.77	4.38
83,333	53111.28	4.82	92.99	4.13a	45203.95	8.13	72.07	4.38
SEm ±	4681.73	0.14	3.09	0.17	5347.52	0.24	3.22	0.53
LSD	NS	NS	NS	0.343	NS	NS	NS	NS
Planting materials								
Mother rhizome	67273.3a	6.27	99.48	3.22b	60375.27a	8.2	76.87a	3.25b
Primary rhizome	60166.6b	5.28	95.5	3.38ab	48435.95b	8.19	71.61b	4.16a
Secondary rhizome	42786.62c	5.03	86.22	3.65a	30820.64c	8.14	62.95c	4.87a
SEm ±	2715.4	0.17	2.13	0.19	2852.13	0.2	2.235	0.42

LSD	5419.93	NS	4.25	0.38	5692.86	Ns	4.461	0.846

Table 3: Effect of planting methods, planting density and planting material on plant height, number of tillers and fresh turmeric yield (2012/2013 and 2013/2014).

Summery and Conclusion

Turmeric belongs to family Zingibraceae and it is valued for its underground orange colored rhizome which is used as natural coloring agent for food, beverages, cosmetics and dye. It also has good economical, medicinal and social importance in Ethiopia. In Ethiopia, production and productivity of turmeric is very low as compared to other countries due to several problems out of this poor agronomic practices is the major one. Planting method is soil management tool which has an impact on plant growth and yield of turmeric. Plant distance is an important factor for higher production and gives equal opportunity to the plants for their survival and best use of other inputs. In the other hand type and weight of planting materials used affects the vigor of the plant and crop yield per unit area as well as the cost of production. This experiment was designed to answer optimum planting material, population density and method of planting to enhance turmeric yield and quality at Tepi southwestern Ethiopia. From the study we concluded that mother rhizome planting material, higher population density and ridge planting method showed better yield and quality of turmeric at Tepi growing condition. Further study should undertake other turmeric production potential areas of the country to give good inference.

References

1. Osawa T, Sugiyama Y, Inayoshi M, Kawakish S (1995) Antioxidative activity of tetrahydrocurcuminoids. Biosci Biotech Biochem 59: 1609-1612.
2. Roukens O, Tadele W, Tamrat K (2005) Export potential of Ethiopian oleoresins, Ethiopian export promotion Agency, Addis Ababa, Ethiopia, pp: 13-17.
3. Borget M (1993) Spice plant. The Tropical Agriculturalist. CTA, Macmillan, London.
4. Pruthi JS (1999) Major spices of India crop management postharvest technology. Indian Council of Agricultural Research (ICAR), India.
5. Chattopadhayay SB, Ghosh SK, Mukhopadhyay TP (1993) Effect of planting distance on growth and yield of turmeric. Indian Agric 37: 123-126.
6. Gill BS, Kaur S, Saini S (2002) Effect of spacing and farmyard manure on growth and yield of flat and ridge planted turmeric (Curcuma longa L.). Extended summaries, pp: 301-303.
7. Holliday R (1960) Population and crop yield. Nature 186: 22-24.
8. Gill BS, Kaur S, Saini SS (2001) Effect of spacing and farmyard manure on growth and yield of flat and ridge planted turmeric (Curcuma longa L.). Extended Summaries 1: 26-30.
9. Philip J (1985) Effect of plant density on yield and yield component of turmeric. Indian Cocoa Arecanut Spices J 9: 93-96.
10. Randhawa KS, Mishra KA (1974) Effect of sowing dates, seed size and spacing on the growth and yield of turmeric. Punjab Hort J 14: 53-55.
11. Meenakshi NY, Sulikeri GS, Hedge RV (2001) Effect of planting material P and K nutrition on plant growth of turmeric. Karnataka J Agric Sci 14: 194-196.
12. Chandra R, Decai AR, Govind S (1997) Effect of foliar spray of Mg and planting materials on growth and yield of turmeric. Journal of Hill Research 10: 1-4.
13. Govinden NY, Wong J, Cheong K (1995) Revue-Agricole et sucriere-de-iIle-maurice. Port Louis, Mauritius 74: 1-8.
14. Kumer B, Gill BS (2009) Effect of method of planting and harvesting time on growth, yield and quality of turmeric (Curcuma longa L.). Journal of Spices and Aromatic crops 18: 22-27.
15. Balwinder K, Gill BS (2010) Growth, yield and quality of turmeric (Curcuma longa L.) as influenced by planting method, plant density and planting material. Journal of Spices and Aromatic crops 19: 42-49.
16. Ramachandran M, Muthuswami S (1984) Studies on the influence of method of planting and spacing on yield and quality of turmeric. South Indian Hort 32: 85-87.
17. Singh J, Malik YS, Nehra BK, Partap PS (2000) Effect of size of seed rhizomes and plant spacing on growth and yield of turmeric (Curcuma longa L.). Haryana J Hort Sci 29: 258-260.
18. Alam MK, Islam Z, Rouf MA, Alam MS, Mondal HP (2003) Response of turmeric to planting material and mulching in the hilly region of Bangladesh. Pak J Biol Sci 6: 7-9.
19. Philip J (1983) Effect of different planting materials on growth, yield and quality of turmeric. Indian Cocoa Arecanut Spices J 8: 8-11.