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RESEARCH PAPER

Effect of mulching, spacing and intercropping of green gram (*Vigna radiate*) on growth, yield and quality of turmeric (*Curcuma longa* L.)

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Abstract : An experiment was conducted during *Kharif* season of 2011-12 to study the effect of mulching, spacing and intercropping of green gram (*Vigna radiate*) on growth, yield and quality of turmeric (*Curcuma longa* L.). The soil of experimental field was categorized as loamy-sand. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications and eleven treatments. The results indicates the rate of increase in plant height was higher up to 120 days after planting, there after the plant height increasing rate slowed down. Maximum plant height 74.7 cm was observed in treatment T_{10} where inter row spacing of turmeric was 37.5 cm and mulch was applied as compared with other treatments. The number of tillers was maximum under turmeric + green gram intercropping systems with mulching at inter row spacing of 60 cm in turmeric crop. The data revealed that the sole turmeric with mulching treatment (T_2) produced maximum fresh rhizome yield (210.0 q/ha), dry rhizome yield (63.1 q/ha) and processed yield (57.8 q/ha) as compared to other intercropping treatment combinations with or without mulch application. Turmeric intercropped with green gram (30 cm inter row spacing in turmeric) produced (205.9 q/ha) fresh rhizome yield closely followed by sole turmeric with mulching (210.0 q/ha). The curcumin content and oil content was not influenced by intercropping, spacing and mulching that is observed from experimental study. Turmeric intercropped with green gram at inter row spacing of 30 cm is a good option.

Key Words : Turmeric, Green gram, Mulching, Intercropping, Spacing

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INTRODUCTION

Turmeric (*Curcuma longa)* is an herbaceous plant belonging to family *Zingiberaceae* and order–*Zingiberalis*. It is an important spice as well as medicinal plant.

The thick underground stem is major produce of the turmeric crop. The yellow colour of the rhizome is attributed to a mixture of curcuminoides, the major being crystalline substance called curcumin. The rhizome contains 1.8-5.4 per cent of curcumin content and 2.5-7.5 per cent of essential oil (Turmerol). Turmeric is grown for its rhizomes, which have many uses. It is used in the

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preparation of cosmetic goods, medicines and food industries, etc. It is also used as a principle ingredient in Indian culinary as curry powder. Turmeric is extensively used as stimulant, blood purifier, remedy against skin diseases, itches, pain etc. The increasing demand for natural products as food additives makes turmeric as ideal produce as food colourant. Turmeric originated in tropical South-East Asia. It is extensively cultivated in India, Sri Lanka, Bangladesh, China, Thailand, Taiwan, Peru, Malaysia, Indonesia and Pakistan. India is the largest producer, consumer and exporter of turmeric in the world. India accounts for 80 per cent of worlds output of turmeric (Anonymous, 2012). In India turmeric is mainly cultivated in Andhra Pradesh, Tamil Nadu, Orissa, Kerala, West-Bengal, Maharashtra and North-Eastern States. In India area under turmeric crop was 183 thousand hectares with production of 792 thousand tonnes (Anonymous, 2012).

Turmeric crop has a good potential to offer an alternative to existing cereal based mono cropping system of Punjab. Presently, it is not cultivated on large scale, except by few progressive farmers. The Punjab state meets its demand from southern states. Cultivation of turmeric in the state will be helpful not only to meet its demand but also to help the country to boost its export. In Punjab, Turmeric crop is sown in the end of April and beginning of May. Turmeric is slow growing crop at its early growth phase, so it does not cover the soil very fast and the solar energy remains unutilized. It offers good scope of growing intercrop which helps in utilizing the solar radiation during period of slow growth rate in the initial growth stage of turmeric and increase remuneration of the farmers by harvesting the maximum benefits of natural resources. Intercropping is growing of two or more crops simultaneously in the same field during a growing season and are the practical application of ecological principles such as diversity, crop interaction and other natural regulation mechanisms. Green gram may be a good intercrop mature in 60 days and increase the per unit area production, which in addition to monetary benefits. It improves the soil fertility by fixing atmospheric nitrogen through N-fixing bacteria, adds organic matter to soil and also modify the microclimate of the main crop. Yamgar *et al.* (2006) and Mahfuza *et al.* (2012) observed higher yield under intercropping. Intercropping give more benefits under proper spacing, change the spacing of main crop and intercropping with other crops gave additional benefits than the sole crop. The yield of turmeric can be increased by adopting improved production technology like proper plant spacing. Turmeric faces major problems like poor germination; poor initial growth and large demand of irrigation water and weed infestation. To solve these problems and to reduce frequency of irrigation or to increase interval of irrigation, mulching can play an important role. Sanyal and Dhar (2008) observed the significant effect of mulching on growth and yield of turmeric. Keeping all the points in view the present study was conducted to fulfill the following objectives :

– To study the effect of mulching on growth and yield of turmeric intercropped with green gram.
– To study the effect of spacing on growth and yield of turmeric intercropped with green gram.

MATERIAL AND METHODS

The present study entitled, **"**Effect of mulching, spacing and intercropping of green gram (*Vigna radiate*) on growth, yield and quality of turmeric (*Curcuma longa* L.)." was conducted at the Students' Research Farm, Khalsa College, Amritsar during *Kharif* season of 2011-12 which is situated at 31° 38' N latitude with 70° 52' E

Table A : Treatment details

Sole crop of turmeric at recommended spacing (30×20 cm).	T_1
Treatment one + mulching @ 6 tonne per hectare.	T_2
One row of turmeric + one row of green gram at their standard spacing (Inter row spacing between turmeric was 60 cm).	T_3
Treatment three + mulching.	T_4
One row of turmeric + one row of green gram at 75 per cent of standard spacing of green gram (inter row spacing between turmeric was 52.5 cm).	T_5
Treatment five + mulching.	T_6
One row of turmeric + one row of green gram at 50 per cent of standard spacing of green gram (inter row spacing between turmeric was 45 cm).	T_7
Treatment seven + mulching.	T_8
One row of turmeric + one row of green gram at 25 per cent of standard spacing of green gram (inter row spacing between turmeric was 37.5 cm).	T_9
Treatment nine + mulching.	T_{10}
One row of green gram sown in between turmeric crop where no extra spacing was given to green gram (inter row spacing between turmeric was 30 cm).	T_{11}

longitude at an altitude of 236 m above the mean sea level. Amritsar tract is characterized by semi humid climate, where both winters and summers are extreme. The mean, minimum and maximum temperature shows considerable fluctuation during summer and winter. The average maximum temperature of about 45-48^0 C is not uncommon during summer and frequent frosty spells are experienced in the months of December and January. The monsoon generally starts in the first week of July. The average annual rainfall fluctuates around 75 mm, the major part of which is received from July to September with a few showers of cyclonic rains is received during winter months. The soil of experimental field was categorized as loamy-sand. The experiment was laid out in Randomized Complete Block Design with four replications and eleven treatments (Table A).

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Plant height :

The plant height is an important parameter of growth and general development of the crop. It indicates the adaptability, vigour and strength of the crop to the existing environmental conditions. The plant height was recorded at 120 DAP. The data presented in Table 1 revealed that rate of increase in plant height was higher upto 120 days after planting, there after the plant height increasing rate slowed down. Maximum plant height 74.7 cm was observed in treatment T_{10} where inter row spacing of turmeric was 37.5 cm and mulch was applied. Least plant height 61.7 cm was observed in sole turmeric and there mulch was not applied. The intercropping of green gram with less spacing and mulch treatments produced significantly taller plants than sole turmeric. This might be due to the application of mulch had favourable effect on plant height by modifying the soil environment by maintaining favourable temperature, increase soil moisture, increase nutrient availability and better weed control.The mulch application produced taller plants has also been reported by Mohanty *et al.* (1991); Gill *et al.* (1999); Swain *et al.* (2007); Junior *et al.* (2005) and Manhas (2009).

Number of tillers per plant :

The data revealed (Table 1) that number of tillers were maximum (2.9) under turmeric + green gram intercropping system at 60 cm inter row spacing in turmeric with mulching as compared to without mulching or other treatments. Least number of tillers per plant was 1.9 observed in treatment where turmeric was sown as sole and without mulch application. The effect of mulch and intercropping on number of tillers per plant was significant and it was higher in T_4 (2.9) from T_1 (1.7), T_7 (2.4), T_8 (2.5), T_9 (2.2), T_{10} (2.3), T_{11} (2.0) and was par with T_3 (2.8), T_5 (2.6), T_6 (2.7). Mulched plots produced higher number of tillers per plant as compared to plots where mulch was not applied. This might be due to intercropping at proper spacing there mulch was applied to plots produced better growth and development of the plant. Singh and Randhawa (1988), Verma and

Table 1: Effect of different treatments on plant height, number of tillers, fresh rhizome, dry rhizome, processed rhizome yield (q/ha) of turmeric

Treatments	Plant height 120 DAP (cm)	No. of tillers per plant (at harvest)	Fresh rhizome yield of turmeric (q/ha)	Dry rhizome yield of turmeric (q/ha)	Processed rhizome yield of turmeric (q/ha)
T_1 (T_{Sole})	61.7	1.9	188.4	57.6	52.8
T_2 (T_{Sole}+M)	63.0	2.3	210.0	63.1	57.8
T_3 (1RT+1RGG) (60cm inter row spacing in turmeric)	63.0	2.8	117.5	35.5	32.6
T_4 (T_3+M)	64.5	2.9	125.3	37.9	34.7
T_5 (1RT+1RGG) (52.5cm inter row spacing in turmeric)	64.7	2.6	132.1	40.0	36.6
T_6 (T_5+M)	67.7	2.7	135.5	41.0	37.6
T_7 (1RT+1RGG) (45cm inter row spacing in turmeric)	68.0	2.4	150.6	45.6	41.8
T_8 (T_7+M)	70.0	2.5	157.7	47.7	43.7
T_9 (1RT+1RGG) (37.5cm inter row spacing in turmeric)	70.2	2.2	170.5	51.6	47.3
T_{10} (T_9+M)	74.7	2.3	176.4	53.4	48.9
T_{11} (1RT+1RGG) (30 cm inter row spacing in turmeric)	62.7	2.0	205.9	62.3	57.1
C.D.(P=0.05)	4.05	.31	19.87	5.88	5.39

Sarnaik (2006) has also been reported that application of mulch increase the number of tiller per plant.

Fresh rhizome yield of turmeric :

Rhizome yield of turmeric per unit area is the main concern to the economy of the growers. The data revealed that in Table 1 produced fresh rhizome yield of turmeric significantly higher in T_2 followed by T_1, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10} and at par with T_{11}. Sole turmeric with mulching treatment (T_2) in Table 1 produced maximum yield (210.0 q/ha) as compared to other intercropping treatment combinations with or without mulch application. This was due to the higher plant population under sole turmeric with mulching as compared to intercropping or without mulching treatments. Turmeric intercropped with green gram (30 cm inter row spacing in turmeric) produced (205.9 q/ha) fresh rhizome yield closely followed by sole turmeric with mulching (210.0 q/ha). Silva *et al*. (2004) and Kandiannan and Chandaragir (2006) reported that the yield of turmeric was highest at closer spacing. Turmeric and green gram (60 cm inter row spacing in turmeric) intercropping system obtained least yield (117.5 q/ha) of fresh rhizome as compared with other intercropping treatments. It may be due to less number of plants per unit area. Green gram intercrop covers half an area of the total area, resulting decrease in the plant population of turmeric as compared with sole turmeric. Manhas *et al.* (2011) also recorded the higher fresh rhizome yield with mulching.

Dry and processed rhizome yield :

The results observed from experiment presented in the Table 1 revealed that intercropping increases the dry rhizome yield of turmeric with the application mulching. The data indicated that maximum dry rhizome yield (63.1 q/ha) was produced when sole turmeric was grown with mulch application where was closely followed by turmeric + green gram (30 cm inter row spacing in turmeric) (62.3 q/ha) and which was more than other treatment combinations. This might be due to the beneficial effect of mulch resulted in more number of tiller and number of rhizome. Kumar *et al.* (2008) have also been recorded higher dry rhizome yield of turmeric with mulching.

Turmeric is generally marketed after processing, so it is the yield of processed turmeric which affects the economic returns of the farmer and data on the processed rhizome yield (q/ha) were recorded and presented in the Table 1. The processed rhizome yield of 57.8 q/ha was produced higher in T_2 where mulch was applied as compared with other treatments or without mulching. Processed rhizome yield in different treatments behave similarly as it was in fresh and dry rhizome yield. The effect of mulch on processed yield was significant. This might be due to the effect of mulch improves the growth and development of plants, more fresh and dry rhizome yield. Manhas and Gill (2010) reported the highest processed rhizome yield was recorded when crop was mulched.

Curcumin content and oil content :

The beautifull yellow colour of turmeric is due to the presence of crystalline substance called curcumin. The intensity of yellow colour in the turmeric rhizome directly depends upon the quantity of crcumin present. The data observed that in Table 2 the content of curcumin was not influenced by intercropping and mulching. However, numerically higher curcumin content (2.69) was observed in T_8 followed by T_4 (2.68), T_5 (2.68), T_6 (2.68), T_7 (2.68), T_9 (2.68), T_{10} (2.68), T_2 (2.67), T_3 (2.67),

Table 2 : Effect of different treatments on curcumin and oil content of turmeric

Treatments	Curcumin (%)	Oil content (%)
T_1 (T_{Sole})	2.65	.59
T_2 (T_{Sole}+M)	2.67	.60
T_3 (1RT+1RGG) (60cm inter row spacing in turmeric)	2.67	.63
T_4 (T_3+M)	2.68	.63
T_5 (1RT+1RGG) (52.5cm inter row spacing in turmeric)	2.68	.62
T_6 (T_5+M)	2.68	.62
T_7 (1RT+1RGG) (45cm inter row spacing in turmeric))	2.68	.61
T_8 (T_7+M)	2.69	.61
T_9 (1RT+1RGG) (37.5cm inter row spacing in turmeric)	2.68	.61
T_{10} (T_9+M)	2.68	.61
T_{11} (1RT+1RGG) (30 cm inter row spacing in turmeric)	2.66	.60
C.D.(P=0.05)	NS	NS

NS= Non-significant

T_{11} (2.66) and T_1 (2.65). These results are in accord with those obtained by Sanwal *et al*. (2007).

Turmeric contains small proportion of oil. It imparts aroma, flavour and other properties in turmeric. In view of this, oil content was determined from rhizomes to see the effect of different treatments. The data revealed that in Table 2 the oil content was 0.59, 0.60, 0.63, 0.63, 0.62, 0.62, 0.61, 0.61, 0.61, 0.61 and 0.60 per cent in T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10} and T_{11}, respectively. Oil content statistically remained unaffected by the application of different treatments.

Conclusion :

From experiment entitled "Effect of mulching, spacing and intercropping of green gram (*Vigna radiate*) on growth, yield and quality of turmeric (*Curcuma longa* L.)" concluded that turmeric intercropping with green gram at 30cm inter row spacing is a good option. Application of mulches increased the plant height, number of tillers per plant as compared to without mulch. The number of tillers per plant also increased in those plots where spacing was more as compared to closer spacing. Turmeric sown with intercrop at proper spacing with mulch produced significantly higher fresh, dry and processed rhizome yield as compared to no mulching or other treatments. Curcumin content and oil content was not influenced by intercropping and mulching. It is approximately same under all treatments.

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