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Effect of fertigation and mulching on yield and yield attributes studies in papaya under South Gujarat conditions

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Abstract: A study was undertaken to evaluate yield and yield attributes of papaya cv. Red Lady (786) with respect to fertigation and mulching as per the treatments *viz.,* 1st factor three levels of N and K @ 100, 80 and 60% of recommended dose (200:200:250), 2nd factor two levels of splits and 3rd factor two levels of mulching of black plastic mulch @ 20% area coverage (50 Micron(μ) and it was analyzed in randomized block design with factorial concept. An overall result of yield attributes of papaya was found higher value in the treatment fertigation level @ 100% recommended dose fertilizer. Adoption of fertigation level @ 100% recommended dose of fertilizer (200g N, 200 g P_2O_5 and 250 g K_2O) recorded significantly highest average fruit weight (1.13 and 1.10 kg) and fruit yield (74.34 and 69.34 tonne/ha) in both the locations as compared to control.

Key words: Papaya, Drip irrigation, Split, Black plastic mulch (BPM) and Fertigation

Introduction

Papaya (*Carica papaya* Linn.) is an important fruit crop of tropical world and has long been known as wonder fruit of the tropics. It requires less area for growth, comes to fruiting in a year, is easy to cultivate and provides more income next to banana with reference to Jadhav *et al.* (2015). Improved production technology on papaya has been developed for different agro-climatic regions of the country. However, it is felt that precision farming be used in India, it will be possible with the introduction of advanced techniques in papaya cultivation like water management through drip irrigation, fertigation, crop geometry, plastic mulching and tissue culture techniques with introduction and multiplication of excellent varieties. In Gujarat, papaya is grown in 17,800 ha with the productivity of 54.70 t/ha as Anonymous (2011).Though, the productivity is more than the national average of 24.3 t/ha, yet there is good scope of increasing productivity of papaya by adopting both drip irrigation with fertigation of split fertilizer application and black polythene mulching. This has been already proved in different crops and the extent of an increase in yield varies from 12 to 32 per cent along with considerable savingsof water and fertilizer as Solia *et al.* (2010). Further, mulching along with drip has been found to be more beneficial in increasing productivity as Tank *et al.* (2011). That why the present study has been planned with an objective to find out the effect of fertigation, split and mulching on yield of papaya cv. Red Lady.

Materials and Methods

An experiment was conducted with twelve treatments in Factorial Randomized Block Design (FRBD) with three replications at two locations *i.e.* 1) Regional Horticultural Research Farm (RHRF), Navsari and 2) Fruit Research Station (FRS), Gandevi, Navsari Agricultural University, Navsari (Gujarat). Papaya variety of Red Lady was planted at a spacing of 2.4 x 1.8 m. The lateral lines of 16 mm diameter with online two drippers (8 lph) were placed 30 cm away on either side of papaya plant. The system was operated at 1.2 kg/cm^2 pressure on alternate day.The complete dose of farm yard manure (FYM) (10 kg) was applied at time of planting, while nitrogen and potash were applied @ 100%, 80% and 60% in fourteen (S_1) and eighteen (S_2) equal splits, without mulching and with mulching black polythene @ 20 % coverage (50 micron) at 15th days intervals after forty-five and fifteen days after transplanting of seedlings of papaya cv. Red Lady. Nitrogen and potash were applied in the form of urea and muriatic of potash (MOP), respectively as per treatment. Recommended dose of Phosphorus were applied @ 100%, 80% and 60% RDF in two equal splits first at $1^1/_2$ month and second at 3 months after transplanting seedlings. Details of the experiment have been showed below in treatment:

Factor I: Fertilizers treatments: F_1 : N and K_2O @ 100 % RD; F_2 : N and K_2O @ 80 % RD; F_3 : N and K_2O @ 60 % RD

Factor II: Fertilizer split treatments: S_1 : 14 Splits of N and K; S_2 : 18 Splits of N and K

Factor III: Mulching treatments: M_0 : Without mulching; M_1 : With mulching of 20% coverage (50 micron)

Treatment combinations: $F_1S_1M_0$; $F_1S_2M_1$; $F_2S_1M_1$; $F_1S_2M_0$; $F_2S_1M_0$; $F_2S_2M_1$; $F_3S_1M_1$; $F_1S_1M_1$; $F_2S_2M_0$; $F_3S_1M_0$; $F_3S_2M_1$

Results and Discussion

The results of study envisaged that effect of fertigation and mulching gave significant increase in the yield over control**.** Higher

Table-1: Effect of fertigation and mulching on number of fruits per plant, fruit length and pulp thickness of papaya cv. Red Lady

Factor levels	Number of fruit / Plant			Fruit length (cm)			Pulp thickness (cm)		
	Gandevi	Navsari	Pooled	Gandevi	Navsari	Pooled	Gandevi	Navsari	Pooled
Fertilizer levels									
F_1	28.19	26.56	27.38	23.05	22.80	22.93	3.35	3.31	3.33
F_2	27.65	25.94	26.80	22.12	21.75	21.94	3.30	3.28	3.29
F_3	20.91	19.86	20.39	18.76	18.50	18.63	3.07	3.05	3.06
S. Em.±	1.04	0.97	0.70	0.50	0.50	0.35	0.07	0.07	0.05
C. D.	3.06	2.85	2.00	1.45	1.49	0.99	0.21	0.22	0.15
Split levels									
S_1	23.54	22.35	22.95	20.08	19.82	19.95	3.11	3.09	3.10
S_2	27.63	25.88	26.76	22.47	22.21	22.34	3.37	3.34	3.36
S. Em.±	0.85	0.79	0.58	0.40	0.41	0.29	0.06	0.06	0.04
C. D.	2.50	2.33	1.64	1.18	1.25	0.82	0.18	0.18	0.12
C. V.%	14.12	13.99	14.07	8.04	8.37	8.21	7.85	7.99	7.92

C. D at 5 % level. The interactions were found non-significant.

Table-2: Effect of fertigation, split and mulching on fruit diameter (cm) of papaya cv. Red Lady

Factor levels	Fruit diameter (cm)								
	280 DAP			300 DAP			320 DAP		
	Gandevi	Navsari	Pooled	Gandevi	Navsari	Pooled	Gandevi	Navsari	Pooled
Fertilizer levels									
F_1	43.65	43.50	43.57	43.67	43.58	43.63	43.33	43.52	43.42
F_2	41.93	41.76	41.84	41.93	41.84	41.88	41.58	41.78	41.68
F_3	39.25	39.32	39.28	39.16	39.15	39.16	39.06	38.83	38.95
S. Em.±	1.16	1.08	0.77	1.14	0.92	0.78	1.14	1.12	0.77
C. D.	3.41	2.58	2.21	3.35	3.29	2.23	3.35	3.29	2.20
Split levels									
S_1	39.96	39.80	39.88	39.97	39.85	39.91	39.63	39.82	39.73
S_2	43.26	43.25	43.25	43.20	43.16	43.18	43.02	42.92	42.97
S. Em.±	0.95	0.88	0.64	0.93	1.12	0.64	0.93	0.91	0.64
C. D.	2.78	2.58	1.82	2.74	3.29	1.84	2.73	2.69	1.84
C. V.%	9.69	8.99	9.35	9.52	9.38	9.45	9.52	9.38	9.36
	C. D at 5 % level					DAP-Days after transplanting			

The interactions were found non-significant.

Table-3: Effect of fertigation and mulching on fruit stalk length (cm) of papaya cv. Red Lady

Factor levels	Fruit stalk length (cm)		
	Gandevi	Navsari	Pooled
Fertilizers levels			
F_1	7.48	8.75	8.12
F_2	8.21	8.22	8.22
F_3	6.29	5.55	5.92
S. Em.±	0.30	0.27	0.20
C. D.	0.88	0.80	0.58
Split levels			
S_{14}	7.28	6.28	6.78
S_{18}	8.70	8.73	8.71
S. Em.±	0.24	0.22	0.36
C. D.	0.72	0.64	NS
Mulch levels			
M_o	7.58	7.11	7.35
M_1	8.41	7.91	8.16
S. Em.±	0.24	0.22	0.16
C. D. at 5%	0.72	0.64	0.46
C. V.%	12.98	12.46	12.75

The interactions were found non-significant

number of fruits per tree was noted under fertilizer level with N and K_2O @ 100 % RDF (F1) during the period of experimentation at both the centres and in pooled analysis. There was recorded significant difference in number of fruits per tree with respect to different treatments.Fruit length 23.05, 22.80 and 22.90cm (Table 1), pulp thickness 3.35, 3.31 and 3.33cm (Table 1), fruit diameter on 280 days after planting 43.65, 43.50 and 43.57; on 300 days after transplanting 43.57, 43.58 and 43.63 cm; on 320 days after transplanting 43.33, 43.52 and 43.42 cm (Table 2), average fruit weight 1.13, 1.10 and 1.12 kg (Table 4)and fruit yield 74.34, 69.34 and 71.84 t/ha was significantly recorded the highest in the plants with received treatment $F_1$100% @ RDF N and K_2O). The similar tends also found in attributes likefruit length 8.70, 8.73 and 8.71cm (Table 2), pulp thickness 3.37, 3.34 and 3.36 cm (Table 2), fruit diameter on 280 days after planting 43.26, 43.25 and 43.25cm; on 300 days after transplanting 43.20, 43.16 and 43.18 cm; on 320 days after transplanting 43.02, 42.92 and 42.97 cm (Table 2), average fruit weight 1.09, 1.06 and 1.08 kg (Table 4) and fruit yield 70.22, 65.23 and 67.73 t/ha was significantly recorded the highest in the plants with received treatment S_2 (18 splits) fertigation through drip application of recommended dose of N and K_2O,

Table-4: Effect of fertigation and mulching on average fruit weight (kg), fruit yield (kg/plant) and fruit yield (t/ha) of papaya cv. Red Lady

Factor levels	Average fruit weight (kg)			Fruit yield (kg/plant)			Fruit yield (t/ha)		
	Gandevi	Navsari	Pooled	Gandevi	Navsari	Pooled	Gandevi	Navsari	Pooled
Fertilizer levels									
F_1	1.13	1.10	1.12	32.11	29.95	31.03	74.34	69.34	71.84
F_2	1.08	1.05	1.07	30.11	27.45	28.78	69.71	63.55	66.63
F_3	0.84	0.81	0.83	17.05	16.14	16.60	39.48	37.37	38.42
S. Em.±	0.02	0.02	0.01	1.13	0.78	0.68	2.63	1.81	1.94
C. D.	0.35	0.05	3.88	3.33	2.29	1.94	7.72	5.31	5.70
Split levels									
S_1	0.94	0.92	0.93	22.51	20.85	21.68	52.13	48.27	50.20
S_2	1.09	1.06	1.08	30.33	28.17	29.25	70.22	65.23	67.73
S. Em.±	0.02	0.01	0.01	0.92	0.63	0.56	2.15	1.48	1.59
C. D. @ 5%	5.18	4.21	3.21	2.72	1.87	1.59	6.30	5.34	4.66
C. V.%	7.38	6.14	6.80	14.91	11.05	13.27	14.90	11.05	12.97

The interactions effects were found non-significant

which is closely followed by F_2 (80% @ N and K_2O RDF) applied through split (18 splits) fertigation. The similar trend during the period of experimentation at both the locations and in pooled analysis was also observed in average fruit weight (kg), fruit diameter (cm), fruit yield (kg/plant) and yield (t/ha).

The size of fruits and yield of plant have the cumulative effect of various attributes as affected by macro nutrients through higher rate of cell division and enlargement, photosynthesis and increase in enzymatic activities. The adequate availability of nutrient might have helped for better flower bud differentiation, primordial development and ultimately increased flower production in papaya. The results of Veerannah & Selvaraj (1984), Kumar *et al.* (2006) and Yadav *et al.*(2011) in papaya yield are in agreement with the present experiment and Shirgure *et al.* (2001) in sweet orange, Sen (1985) in pineapple; Singh and Sharma(1961),Yadav (1999) and Oliveira *et al*. (2004) in phalsa. The lack of metabolism of nitrate to protein, leads to increased nitrate levels in the plant, which may induce undesirable effects such as increased disease incidence and lower quality of produce. The marked effect of nitrogen on fruit size (cm) and fruiting may be due to fact that absorbed nitrogen combined with carbohydrates in leaves to the formation of amino acids, proteins and amides in Tiwari *et al.* (1968) and Agrawal *et al. (*2010).

Drip fertigation with water soluble fertilizer registered higher fruit yield over drip and furrow irrigation methods even with same level and method of normal fertilizer application as reference with Almeida *et al.* (2003). The results are in agreement with Jeyakumar *et al.* (2001) in papaya, Shirgure*et al.* (2001) in Nagpur mandarin, Chandrakumar *et al*. (2001), Mahalakshmi *et al*. (2001), Reddy *et al.* (2002) and Pandey *et al.* (2005) in banana and Colapietra (1987), Gnanamurthy and Manickasundram (2001) in oil palm. Fertigation has proved successful tool in a wide range of horticultural crop particularly in fruit crops like strawberry and banana as reference to Locascio *et al*. (1977) and Melo *et al*. (2010) respectively. The nitrogen fertigation increased the yield of various fruit crops like Valencia orange of Koo and Smjstrala (1984), Acid lime of Shirgure *et al. (*2001), Naval orange and Sunburst mandarin of *Anon*. (1990). Slow and frequent watering eliminated wide fluctuation of soil moisture under drip irrigation, which resulted in better growth and yield. Likewise, the advantageous effect of drip irrigation has been proved by many workers *viz.,*Nath and Pathak (2006) as well as Sen and Deshmukh (2000) in guava and aonla, respectively. The macro nutrients which are required more in quantity but essential for various physiological activities as mentioned by Singh *et al.* (1990). It may be attributed to the fact that macro nutrients might have enhanced the physiological processes in papaya leaves in present study which in turn have led to rapid absorption and utilization of nutrients for primary metabolic processes. Potassium is involved in all major physiological processes including photo-assimilation and transport ofassimilates and the conversion of these assimilates into storage products such as sugar, starch, protein and oil/fats by Oliveira *et al*. (2004) and Epstein and Bloom (2005).

The results of two locationsof this study inferred that the application F_1 (N and K_2O @ 100 % Recommended Dose Fertilizer) was favorable to influenced thenumber of fruits per plant, fruit length (cm), stalk length of fruit (cm), pulp thickness (cm), fruit diameter (cm), average fruit weight (kg) and yield (t/ha).

References

Agrawal, N., Panigrahi, H.K., Tiwari, S.P., Agrawal R., Sharma, D. and Dikshit, S.N.: Effect of fertigation through water-soluble fertilizers on growth, yield and quality of papaya (Carica papaya L). *National Seminar on Precision Farming in Horticulture*. p. 507-510 (2010).

Almeida, F.T., Bernardo, S., Sousa, E.F., Marin, S.L.D and Grippa, S.: Growth and Yield of Papaya under Irrigation. *Sci. Agric.,* **60**: 419-424 (2003).

Anonymous: Citrus Research Centre and Agricultural Station, University of California Riverside, p. 20-22 (1990).

Anonymous: State wise area and production of horticultural crops. Ministry of Agriculture, Government of India, Gurgaon, p. 38 (2011).

Chandrakumar, S.S., Thimmegowda, S., Srinivas, B., Reddy, M.C. and Devakumar, N.: Performance of Robusta banana under nitrogen and potassium fertigation. *S. Ind. Horti*., **49**: 92-94 (2001).

Colapietra, M.: The effect of increasing rates of plant nutrients on the qualitative yield of grape vines. A comparison of fertigation and manually applied fertilizer. *Rivistadivitcolturae di enologia,* **40**: 223-239 (1987).

Epstein, E. and Bloom, A.J.: Mineral Nutrition of Plants: Principles and Perspectives. 2nd edition.Sinauer Assoc.,Sunderland, Massachusetts, (2005).

Gnanamurthy, P. and Manickasundram, P.: *In: advances in integrated nutrient management system for sustainable crop productivity and soil fertility*, Tamil Nadu Agricultural University, Coimbatore. p. 110-116 (2001).

Jadhav, P.B., Padhiar, B.V., Ahlawat, T.R. and Chavan, S.M.: Record of Peacock: as a pest in Papaya (*Carica papaya)* in south Gujarat. *Int. J. Curr. Res.,* **7**: 19258-19259 (2015).

Jeyakumar, P., Kumar, N. and Soorianatha, S.K.: Fertigation studies in papaya (*Carica papaya* L.). *S. Ind. Horti.,* **49**: 71-75 (2001).

Koo, R.C.J. and Smjstrala, A.G.: *Proc. Florida State Hart. Sci.*, **91**:8-10 (1984).

Kumar, N., Kumar, R.M.V., Nalina, L. and Selvi, R.: Nutrient use efficiency in tropical fruit crops. *National Symposium on Improving Input Use Efficiency in Horticulture*, IIHR, Bangalore, Society for Promotion of Horticulture, Bangalore. p. 25-27 (2006).

Locascio, S.J., Myers, J.M. and Martin, F.G.: Frequency and rate of fertilization with trickle irrigation for strawberries. *J. Amer. Soc. Hort. Sci.,* **102:** 456-458 (1977).

Mahalakshmi, M.N., Jayakumar, P. and Soorianathasundara, K.: Fertigation study in banana under normal system of planting. *S. Ind. Horti*., **49**: 0-85 (2001).

Melo, A.S., Fernandes, P.D., Sobral, L.F., Brito, M.E.B. and Dantas, J.D.M.: Growth, biomass production and photosynthetic efficiency of banana under fertigation with nitrogen and potassium. *Agronomic Sci. Mag. Fortaleza*, **41**: 417-426 (2010).

Nath, V. and Pathak, R.A.: Effect of drip irrigation on vegetative growth of aonla and guava plant under sodic soil. *Orissa J. Horti.,* **32**: 32-35(2006).

Oliveira, A.M.G. and Caldas, R.C.: Papaya yield under fertilization with nitrogen, phosphorus and potassium. *Brazilian Mag. Fruit Cul.,* **26**: 160-163 (2004).

Pandey, V., Kumar, D. and George, S.: Response of micropropagated Robusta banana to varying combinations of N, P, K nutrition in lateritic soils of coastal Orissa. *Ind. J. Horti.,* **62**: 122-126 (2005).

Reddy, B.M.C., Srinivas, K., Padma, P. and Raghupathi, H.B.: Response of Robusta banana to N and K fertigation. *Ind. J. Horti.,* **59**: 342-348 (2002).

Sen, N.L. and Deshmukh, M.M.: Evaluation of drip irrigation, its evaporation based irrigation scheduling and distribution pattern on performance of guava (*Psidiumguajava* L.*). Advan. Horti. Forestry,* **8:** 25-31 (2000).

Sen, S.K.: Pineapple. In: Fruits of India. Tropical and subtropical, T.K. Bose (Ed.), NayaPrakasham, Culcutta. p. 298-31 (1985).

Shirgure, P.S., Shrivastava, A.K. and Shyam, S.: Fertigation and drip irrigation in Nagpur Mandarin (*Citrus reticulata*L.). *S. Ind. Horti.,* **49-50:** 95-97 (2001).

Singh, D.S.; Singh, S.P. and Maurya, A.N.: Effect of N, P and GA_3 on chemical composition guava cv. Allahabad Safeda during winter season. *Prog. Hort*., **21**: 1-5 (1990).

Singh, J.P. and Sharma, H.C.: Effect of time and severity of pruning on growth, yield and fruit quality of phalsa (*Grewiaasiatica* L.). *Ind. J. Horti.,* **18**: 20-28 (1961).

Solia, B.M., Aklade, S.A., Patil, S.J., Patel, A.P., Malik, M.S., Dhimmar, S. K. and Patil, R.G.: Drip and mulching stuidies in gourd crops under South Gujarat conditions. *Green Farm.,* **3**: 47-49 (2010).

Tank, R.V., Patel, N.L. and Naik, J.R.: Effect of fertigation on growth, yield and quality of papaya (*Carica papaya* L.) cv. MadhuBindu under south Gujarat conditions, *Asian J. Horti.*, **6**: 339-343 (2011).

Tiwari, M.D., Upadhyay, J.S. and Singh, M.P.: Effect of various levels N with and without micronutrients on guava production. *Plant Food Rev.,* Bombay, **8**: 1-6 (1968).

Veerannah, L. and Selvaraj, P.: Studies on growth, dry matter partitioning and pattern of nutrient uptake in papaya. *National seminar on papaya and papain production*, TNAU, Coimbatore. p. 76-78 (1984).

Yadav, A.K.: Phalsa: A Potential New Small Fruit for Georgia, In: J. Janick (ed.), Perspectives on new crops and new uses. ASHS Press, Alexandria, VA, p. 348–352 (1999).

Yadav, P.K., Yadav, A.L., Yadav, A.S., Yadav, H.C. and Singh, Y.P.: Effect of integrated nutrient nourishment on yield attributes and economics of papaya (*Carica papaya* L.) cv. Pusa Dwarf. *Plant Arch.,* **11**: 307-309 (2011).