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Standardization of mulching and fertigation on growth, yield and quality of banana CV grand naine

M Hanuman Nayak[1], G Vijay Krishna P[2], Prashanth T[3], Suresh Kumar[4], Hameedunnisa Begum[5]
[1-5] Department of Fruit science, Horticultural Research Station, Aswaraopet, SKLTSHU, Telangana, India

Abstract
Present investigation was aimed to standardize the mulching and fertigation schedule on growth, yield and quality of banana cv. Grand naine at Horticultural Research Aswaraopet, SKLTSHU, during 2018-2020. Black polythene mulch, organic mulch, 100 percent RDF, 75 percent RDF and 50 percent RDF doses were used as mulching and fertigation treatments. The results that, both mulching materials alone and in combination with 100 percent RDF fertigation significantly influenced, the yield characters in terms of number of fruits per bunch, fruit weight (g), bunch weight (kg), yield (t/ha). Whereas, mulching treatments did not significantly influence the quality parameters *viz*., TSS and shelf life. Among mulching treatments organic mulch (M_2) has recorded maximum yield (49.92 t/ha) by increasing the number of fruits per bunch (112.82), fruit weight (194.39 g) and bunch weight (20.22 kg) compared to control. RDF 100 percent (F_1) treatment has recorded maximum yield (51.72 t/ha) through increasing number of fruits per bunch (107.94), fruit weight (208.49 g) bunch weight (20.94 kg), and also improved the fruit quality parameters *viz*., TSS (22.67 ^{0}Brix) and shelf life (11.11 days) compare to control and other fertigation treatments. Among the interactions organic mulch along with 100 percent RDF (M_2F_1) treatment has recorded maximum yield (52.89 t/ha) by increasing the number of fruits per bunch (118.45), bunch weight (21.42 kg) and also increased the fruit shelf life (11.56 days) compared to control and other combinations.

Keywords: mulching, fertigation, yield, banana and grand naine

Introduction
Banana belongs to the genus Musa of the family Musaceae. Banana is rich source of easily digestible carbohydrates with a calorific value of 67-137/100 g of fruit, and it is good source of vitamin A (190 IU per 100 g) and vitamin C (100 mg/100g) and fair source of vitamin B and B2. Fruits are also rich source of minerals like magnesium, sodium, potassium, phosphorus, and also fair source of calcium and iron. It makes healthy and salt free balanced diet than many other fruits. Its year round availability, affordability, varietal range, taste, nutritive and medicinal value makes it the favourite fruit among all classes of people.

India is the largest banana consumer and producing country in the world followed by Brazil, contributing 15 percent of total world production. In India banana occupies an area of 8.98 lakh hectares with a production of 317.47 lakh tones. The productivity of banana in India is far less than that elsewhere (NHB, 2019) [13]. Growth in population leads to demand for more food production which encouraged for search of innovative methods of production that can obtain higher sustainable yields to feed increasing population. The major hurdle in quality banana production is the lack of professional outlook towards its production and the mismanagement of the available natural resources. An advanced and innovative technology has to be developed to increase production in the crops like banana, which has higher productivity, is the major concern of today's scientific research to feed growing population.

Water is one of the most important constraints which significantly influence quality and productivity of crops. Banana is a tropical plant that requires an ample and frequent supply of water and water deficit adversely affects the crop growth and yield. Most of the investigations have shown that plant growth rate as well as biochemical and physiological processes were directly affected proportional by availability of water in the soil (Hu and Schmidhalter, 2005) [7]. In banana surface irrigation method is most widely used all over the world (Mustafa *et al*., 2003) [12]. Irrigation is an important for all crops, because it influences on growth and development. Availability of adequate amount of moisture at critical stages of plant growth not only optimizes the metabolic process in plant cells, but also increase the effectiveness of the mineral nutrients applied to the crop. Consequently, any degree of water stress may produce deleterious effects on growth and yield of the crop (Saif *et al*., 2003) [16]. In recent past mulching is one of the developing technology among the water management practices for increasing water use efficiency (WUE). Any material spread on the soil surface to protect it from solar radiation or evaporation is called mulch. Different types of materials like wheat straw, rice straw, plastic film, grass, wood, sand *etc*. are used as mulches. They moderate soil temperature and increase water infiltration during intensive rain (Khurshid *et al*., 2006) [9].

Fertigation gives advantages such as higher use efficiency of water and fertilizer, minimum losses of N due to leaching, supplying nutrients directly to root zone in available forms, control of nutrient concentration in soil solution and saving in application cost. Thus, fertigation becomes prerogative for increasing the yield of most of the crops under drip irrigation (Solaimalai *et al*., 2005) [19]. Water and nutrients are the key important factors in banana cultivation and number of research experiments has clearly demonstrated that for high productivity of banana, application of recommended doses of essential nutrients at appropriate crop growth stage is necessary. Hence,

management of these resources in an efficient way is the need of hour. To increase fertilizer use efficient application of nutrients along with irrigation (fertigation) is the best method which can completely fulfill the nutrient requirement of banana. However, many workers carried out their works on mulching and fertigation to improve the crop production of banana in various parts of the world. However, a very few works were carried out on mulching combined with fertigation to enhance the production of banana through maintaining the soil moisture as well as by improving fertilizers use efficiency. Considering the above facts, the present study was aimed to standardize the mulching and fertigation doses on growth, yield and quality parameters of banana cv. Grandnaine.

Materials and Methods

The Present investigation was carried out during 2018-2020 at Horticultural Research Station, Aswaraopet, Telangana State. The soil of the experimental site is sandy clay loam (deep red to brown soils) and is endowed with good drainage. The experiment was initiated by planting tissue culture banana plant at 1.8 X 1.8 m spacing. Field experiment was laid out in Factorial Randomized Block Design with three replications, and nine treatments in each block and they were allotted randomly. Under two factorial randomized block design, mulching factor consists different levels mulching materials *viz*., Black polythene mulch (M_1), organic mulch (M_2) and without mulch (M_0) and fertigation factor consists different levels of fertigation doses *viz*., 100% RDF (F_1), 75% RDF (F_2) and 50% RDF (F_3).

Fertigation levels

F_1- 100 % N and K -300 gm N and 300 gm K_2O per plant (652 gm urea and 500 gm MOP per plant). F_2 - 75 % N and K - 225 gm N and 225 gm K_2O per plant (489 gm urea and 375 gm MOP per plant). F_3 - 50 % N and K - 150 gm N and 150 gm K_2O per plant (326 gm urea and 250 gm MOP per plant).

Details of split application of fertilizers

F_1 (100% RDF) - The total quantity of 652.0 g urea and 500 g MOP per plant were applied in 20 equal splits @ 32.6 g urea and 25.0 g MOP (each split) at weekly intervals. F_2 (75% RDF) - The total quantity of 489.0 g urea and 375.0 g MOP per plant were applied in 20 equal splits @ 25.0 g urea and 19.0 g MOP (each split) at weekly intervals. F_3 (50% RDF) - The total quantity of 326.0 g urea and 250.0 g MOP per plant were applied in 20 equal splits @ 16.0 g urea and 12.5 g MOP (each split) at weekly intervals. In the present experiment ten plants in the each replication were selected to recorded the data on vegetative parameters *viz*., number of leaves at shooting stage and leaf area (m^2), yield parameters *viz*., number of fruits per bunch, fruit weight, bunch weight, and yield and quality parameters *viz*., TSS and shelf life of three cropping seasons (one main and two ratoon crops). Differences between treatments were determined with Analysis of Variance (ANOVA) by using OPSTAT (HAU, Hisar) and Critical Difference (CD) and standard error of mean were calculated.

Results and Discussion

Vegetative parameters

The data depicted in fig. 1 revealing that, both the mulching treatments *ie*., black polythene mulch and organic mulch (M_1 and M_2) has significantly increases the vegetative parameters *viz*., number of leaves and leaf area (m^2) compare to control. Black polythene mulch has recorded maximum number of leaves (20.30) and leaf area (10.13 m^2) which was followed by organic mulch (20.23 and 9.74 m^2 respectively) whereas minimum leaf number and leaf area was recorded in without mulch treatment (19.32 and 7.57 m^2 respectively). The similar increase in vegetative growth in terms of leaf number and leaf area was earlier reported by Liu *et al*., (2014) [11], who reported that, the benefits of using mulch in orchards have been reported in many parts of the world to protect plants from extreme transpiration fluctuation and regulation of soil temperature. Moreover, using mulches help in moisture conservation and reduction of evaporation (Sinkeviciene *et al*., 2009) [18], reserve water at the root zone, increased soil organic matter (Kiristina *et al*. 2013) [10], and it is considered as a source of plant nutrients (Hostetler *et al*. 2007) [6]. These might be reasons behind increase in vegetative growth by using of both the mulching materials under present study.

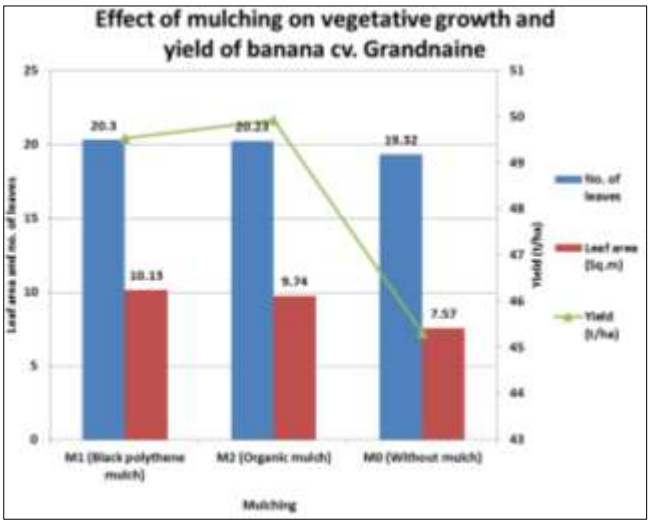

Fig 1: Effect of mulching on vegetative growth and yield of banana cv. Grandnaine

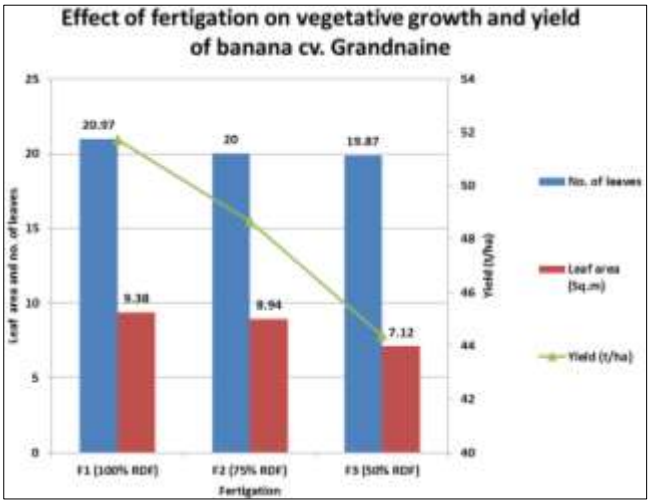

Fig 2: Effect of fertigation on vegetative growth and yield of banana cv. Grandnain

The data depicted in fig. 2 indicate that, fertigation doses were significantly influence the vegetative parameters (number of leaves and leaf area) there was a gradual decrease in vegetative growth in terms of number of leaves and leaf area (m^2) with reduction of fertilizers dose. However, 100% RDF (F_1) recorded maximum number of leaves (20.97) and leaf area (9.38 m^2), which was followed by 75% RDF (F_2) (20.00 and 8.94 respectively) whereas minimum number of leaves and leaf area (m^2) was recorded with 50% RDF (19.87 and 7.12 m^2 respectively). The similar findings were earlier confirmed by Yuv raj and Mahendran (2015) [21] in banana cv. Rasthali and Hanuman N.M *et al*.,(2016a) [4] in banana cv.Grand naine. Pandey *et al*., (2001) [14] reported that, higher levels of nitrogen and potash promote production of more leaves resulting in increased leaf area which have positive correlation with bunch weight and yield in banana. It was evident from the data that, higher amount of nutrient application resulted in more number of leaves leading to increased leaf area. The increased production of leaves may further help to synthesize more photosynthates and flowering stimulus which leads to improved bunch weight (Table 3) and yield (Table 4).

Yield parameters

The data (Table 1 and Fig. 3) shows that mulching and fertigation treatments significantly influenced the number of fruits per bunch. Among mulching materials maximum number of fruits per bunch was recorded with organic mulch (M_2) (112.82) which was followed by black polythene mulch (M_1) (109.62) and minimum number of fruits per bunch was recorded in without mulch (M_0) (86.83). The similar increase in number of fruits per bunch was earlier reported by Eid *et al*., (2018) [2] in Williams banana with organic mulch and Sombo *et al*., (2020) [20] in plantain banana with mulching material. Mulches help in moisture conservation and reduction of evaporation (Sinkeviciene *et al*., 2009) [18], reserve water at the root zone, increased soil organic matter (Kiristina *et al*., 2013) [10], and it is considered as a source of plant nutrients (Hostetler *et al*. 2007) [6]. This might be a reason for increase in number of fruits per bunch with use of mulch compare to control (Table 1 and Fig. 3). 100% RDF (F_1) has recorded significantly maximum number of fruits per bunch (107.94), which was at par with application of 75% RDF (F_2) (105.16) and minimum number of fruits per bunch was recorded with 50% RDF (F_3) (96.17). In banana, the floral differentiation requires minimum functional leaf area. Higher photosynthetic assimilation favoured by improved nutrient status, better differentiation, leading to more finger and better flow of assimilates to developing fingers, could be attributed for more number of fruits per bunch recorded in the treatments that received 100% RDF (Sindhupriya *et al*., 2018) [17]. It is evident that 100% RDF treatment has recorded maximum number of leaf number and leaf area (Fig.2) this might be a reason for more number of fruits per bunch attained by 100% RDF treatment (Table.1). The similar findings were earlier confirmed by Sindhupriya *et al*., (2018) [17] in banana cv. Nandren. There was significant difference among interaction between mulching and fertigation with respect to number of fruits per bunch (Table. 1). Maximum number of per bunch was recorded in organic mulch along with 100% RDF (M_2F_1) (118.45) which was at par with organic mulch along with 75% RDF (M_2F_2) (114.83), black polythene mulch along with 100% RDF (M_1F_1) (114.23) and black polythene mulch along with 75% RDF (M_1F_2) (113.80) and minimum number of fruits per bunch was recorded with without mulch along with 50% RDF (M_0F_3) (82.48). Water or soil moisture conservation nature of mulches and photosynthetic activity acceleration nature of higher dose of fertilizers (100% RDF) might synergistically increase the number of fruits per bunch under present study. The similar synergistic increase in number of fruits per bunch with plant densities and fertigation doses was earlier reported by Pawar *et al*. (2017) [15] in banana.

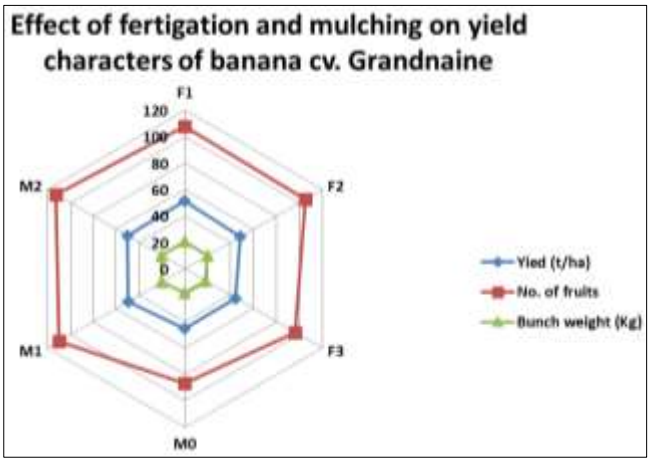

Fig 3: Effect of mulching and fertigation on yield characters of banana cv. Grandnaine.

M_1: Black polythene mulch, M_2 - Organic mulch and M_0 - Without mulch.
F_1: 100% RDF, F_2 - 75% RDF and F_3 - 50% RDF.

Fruit weight (g) varied significantly among the mulching and fertigation treatments imposed (Table 2) under present study. Among mulching treatments maximum fruit weight was recorded with black polythene mulch (M_1) (197.73 g) which was on par with organic mulch (M_2) (194.39 g) and minimum fruit weight was recorded in without much (M_0) (177.32 g). The similar increase in fruit weight with mulching was earlier recorded by Eid *et al*., (2018) [2] in Williams banana with organic mulch and Sombo *et al*. (2020) [20] in plantain banana. Mulches help in moisture conservation and reduction of evaporation (Sinkeviciene *et al*., 2009), reserve water at the root zone, increased soil organic matter (Kiristina *et al*., 2013) [10], and it is considered as a source of plant nutrients (Hostetler *et al*. 2007) [6]. This might be a reason for increase in fruit weight with use of mulch compare to control (Table 2). Among fertigation doses (Table 2) maximum fruit weight was recorded with 100% RDF treatment (F_1) (208.49 g) which was at par with 75% RDF (F_2) (204.14 g) whereas minimum fruit weight was recorded with 50% RDF (F_3) (156.80 g).This might be due to the highest applied nutrients leading to increased growth and vigour associated with photosynthesis and finally translocation of assimilates into the fruits (Sindhupriya *et al*., 2018) [17]. Such assumption gains support from the findings of several workers like Sombo *et al*. (2020) [20] in banana and Eid *et al*. (2018) [2] in williams banana who reported that increased rate of translocation of photosynthetic products from leaves to developing fruits increased fruit weight. The increase in fruit weight with the increasing nitrogen application was also reported by Hanuman,

N. M (2016) [4] in banana cv. Grandnaine and this also lends support to the findings of present study. There was significant difference among interaction between mulching and fertigation with respect to fruit weight (g) (Table. 2). Maximum fruit weight was recorded in black polythene mulch along with 100% RDF (M_1F_1) (229.06 g) which was at par with organic mulch along with 75% RDF (M_2F_2) (226.22 g) and minimum fruit weight was recorded in without mulch along with 50% RDF (M_0F_3) (153.08 g). Water or soil moisture conservation nature of mulches and photosynthetic activity acceleration nature of higher dose of fertilizers (100% RDF) might synergistically increase the fruit weight (g) under present study. The similar synergistic increase in fruit weight (g) with plant densities and fertigation doses was earlier reported by Pawar *et al*. (2017) [15] in banana.

Bunch weight (kg) varied significantly among the mulching and fertigation treatments imposed (Table 3) under present study. Among mulching treatments maximum bunch weight was recorded with organic mulch (M_1) (20.22 kg) which was on par with black polythene mulch (M_2) (20.06 kg) and minimum bunch weight was recorded in without mulch (M_0) (18.35 kg). The similar increase in bunch weight with mulching was earlier recorded by Eid *et al*. (2018) [2] in Williams banana with organic mulch and Sombo *et al*. (2020) [20] in plantain banana. Mulches help in moisture conservation and reduction of evaporation (Sinkeviciene *et al*., 2009) [18], reserve water at the root zone, increased soil organic matter (Kiristina *et al*., 2013) [10], and it is considered as a source of plant nutrients (Hostetler *et al*. 2007) [6]. This might be a reason for increase in fruit weight with use of mulch compare to control (Table 3 and Fig. 3). Among fertigation doses (Table 3) maximum bunch weight was recorded with 100% RDF treatment (F_1) (20.94 kg) which was followed by 75% RDF (F_2) (19.70 kg) whereas minimum bunch weight was recorded with 50% RDF (F_3) (17.98 kg). This might be due to improved photosynthetic efficiency and efficient translocation of photoassimilates to the developing bunch, which ultimately reflect on bunch weight, yield and yield attributing characters (Sindhupriya *et al*., 2018) [7]. As in any other plant, leaves of banana are the chief functional of photosynthetic units. For normal production, a banana crop needs sufficient number of leaves at vegetative phase. The number of functional leaves retained at shooting is considered as an important determinant of yield (Husameldin *et al*., 2013) [8]. In that situation, sustaining leaf production depends again on nutrient availability. The results of the present study also revealed a positive influence between number of leaves and the bunch weight (Fig 2 and Table 3) of the crop which is the highest in the treatment of 100% RDF (F_1). There was significant difference among interaction between mulching and fertigation with respect to bunch weight (kg) (Table. 3). Maximum bunch weight was recorded in organic mulch along with 100% RDF (M_2F_1) (21.42 kg) which was at par with black polythene mulch along with 100% RDF (M_1F_1) (21.41 kg), organic mulch along with 75% RDF (M_2F_2) (20.46 kg), black polythene mulch along with 75% RDF (M_1F_2) (20.05 kg) and without mulch along with 100% RDF (M_0F_1) (20.01 kg) and minimum number of fruits per bunch was recorded with without mulch along with 50% RDF (M_0F_3) (16.44 kg). Water or soil moisture conservation nature of mulches and photosynthetic activity acceleration nature of higher dose of fertilizers (100% RDF) might synergistically increase the bunch weight (kg) under present study. The similar synergistic increase in bunch weight (kg) with plant densities and fertigation doses was earlier reported by Pawar *et al*. (2017) [15] in banana.

The data (Table 4 and Fig. 3) revealed that mulching, fertigation, and interaction treatments significantly influenced the yield (t/ha). Among mulching materials maximum yield was recorded with organic mulch (M_2) (49.92 t/ha) which was on par with black polythene mulch (M_1) (49.53 t/ha) and minimum yield was recorded in without mulch (M_0) (45.31 t/ha). The similar increase in yield was earlier reported by Eid *et al*., (2018) [2] in Williams banana with organic mulch and Sombo *et al*., (2020) [20] in plantain banana with mulching material. Mulches help in moisture conservation and reduction of evaporation (Sinkeviciene *et al*., 2009) [18], reserve water at the root zone, increased soil organic matter (Kiristina *et al*., 2013) [10], and it is considered as a source of plant nutrients (Hostetler *et al*. 2007) [6]. And also it is evident that, mulching material enhance the bunch weight (Table 3) and number of fruits per bunch (Table 1) which might positively correlated with yield (Eid *et al*., 2018) [2] and ultimately enhances the yield per hectare under present study. Among fertigation doses (Table 4) maximum yield was recorded with 100% RDF treatment (F_1) (51. 72 t/ha) which was followed by 75% RDF (F_2) (48.66 t/ha) whereas minimum yield was recorded with 50% RDF (F_3) (44.39 t/ha). In the present study, more number of fruits per bunch (Table 1), fruit weight (Table 2) and bunch weight (Table 3) was recorded in the 100% RDF (F_1) treatment. Bunch weight is a primary function of number of fruits and fruit weight (Amol. 2014) [1]. This might be due to improved photosynthetic efficiency and efficient translocation of photoassimilates to the developing bunch, which ultimately reflect on bunch weight, yield and yield attributing characters (Sindhupriya *et al*., 2018) [7]. As in any other plant, leaves of banana are the chief functional of photosynthetic units. For normal production, a banana crop needs sufficient number of leaves at vegetative phase. The number of functional leaves retained at shooting is considered as an important determinant of yield (Husameldin *et al*., 2013) [8]. In that situation, sustaining leaf production depends again on nutrient availability. The results of the present study also revealed a positive influence between number of leaves and the yield (Fig 2 and Table 4) of the crop which is the highest in the treatment of 100% RDF (F_1). Among the interactions (Table 4) maximum yield was recorded in organic mulch along with 100% RDF (M_2F_1) (52.89 t/ha) which was at par with black polythene mulch along with 100% RDF (M_1F_1) (52.87 t/ha) and organic mulch along with 75% RDF (M_2F_2) (50.51 t/ha). Whereas, the minimum yield was recorded in without mulch along with 50% RDF (M_0F_3) (40.59 t/ha). Similar result of increased yield with 100% RDF through fertigation was also reported by Hanuman N.M *et al.*, (2016b) [5]. Water or soil moisture conservation nature of mulches and photosynthetic activity acceleration nature of higher dose of fertilizers (100% RDF) might synergistically increase the yield (t/ha) under present study. The similar synergistic increase in yield with plant densities and fertigation doses was earlier reported by Pawar *et al*. (2017) [15] in banana.

Table 1: Effect of mulching and fertigation on number of fruits per bunch of banana cv. Grandnaine

Number of fruits per bunch																
Year	**2017-2018**				**2018-2019**				**2019-2020**				**Pooled**			
Treatments	**Mulches**				**Mulches**				**Mulches**				**Mulches**			
Fertigation	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**
F_1	113.53^{d}	117.80^{c}	86.93^{g}	106.08^{b}	115.66^{b}	119.82^{a}	92.46^{f}	109.31^{a}	113.50^{b}	117.75^{a}	94.11^{f}	108.45^{a}	114.23^{a}	118.45^{a}	91.16^{c}	107.94^{a}
F_2	118.27^{b}	128.80^{a}	85.93^{h}	111.00^{a}	112.33^{c}	110.25^{d}	88.33^{g}	103.63^{b}	110.80^{c}	105.45^{d}	86.33^{g}	100.86^{b}	113.80^{a}	114.83^{a}	86.86^{c}	105.16^{a}
F_3	87.34^{f}	106.13^{e}	79.67^{i}	91.04^{c}	110.00^{d}	107.10^{e}	83.11^{h}	100.07^{c}	105.22^{d}	102.33^{e}	84.66^{h}	97.40^{c}	100.85^{b}	105.18^{b}	82.48^{d}	96.17^{b}
Mean	106.38^{b}	117.57^{a}	84.17^{c}		112.66^{a}	112.39^{a}	87.96^{b}		109.84^{a}	108.51^{b}	88.36^{c}		109.62^{b}	112.82^{a}	86.83^{c}	
	F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)	
Factor F	*	0.16	0.51		*	0.34	1.04		*	0.27	0.81		*	1.059	3.175	
Factor M	*	0.16	0.51		*	0.34	1.04		*	0.27	0.81		*	1.059	3.175	
F×M	*	0.29	0.89		*	0.60	1.80		*	0.47	1.41		*	1.834	5.498	

Figures with same alphabets did not differ significantly. ** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant. Values were compared with respective C.D values. M_1 - Black polythene mulch, M_2 - Organic mulch and M_0 - Without mulch. F_1 - 100% RDF, F_2 - 75% RDF and F_3 - 50% RDF.

Table 2: Effect of mulching and fertigation on fruit weight (gm) of banana cv. Grandnaine

Fruit weight (gm)																
Year	**2017-2018**				**2018-2019**				**2019-2020**				**Pooled**			
Treatments	**Mulches**				**Mulches**				**Mulches**				**Mulches**			
Fertigation	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**
F_1	240.53^{b}	210.73^{c}	205.80^{d}	219.02^{a}	235.00^{a}	202.78^{d}	196.40^{e}	211.39^{a}	211.66^{a}	188.28^{d}	185.30^{e}	195.08^{a}	229.06^{a}	200.59^{b}	195.83^{b}	208.49^{a}
F_2	200.67^{e}	250.59^{a}	190.79^{f}	214.01^{b}	210.66^{c}	220.44^{b}	182.66^{f}	204.58^{b}	198.20^{c}	207.65^{b}	175.70^{f}	193.85^{a}	203.17^{b}	226.22^{a}	183.05^{c}	204.14^{a}
F_3	170.96^{g}	165.44^{h}	160.77^{i}	165.72^{c}	160.17^{g}	154.20^{g}	151.92^{g}	155.43^{c}	151.75^{g}	149.44^{g}	146.55^{h}	149.24^{b}	160.96^{d}	156.36^{d}	153.08^{d}	156.80^{b}
Mean	204.05^{b}	208.92^{a}	185.78^{c}		201.94^{a}	192.47^{b}	176.99^{c}		187.20^{a}	181.79^{b}	169.18^{c}		197.73^{a}	194.39^{a}	177.32^{b}	
	F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)	
Factor F	*	0.88	2.64		*	0.80	2.40		*	0.58	1.75		*	2.186	6.544	
Factor M	*	0.88	2.64		*	0.80	2.40		*	0.58	1.75		*	2.186	6.544	
F×M	*	1.52	4.59		*	1.39	4.17		*	1.01	3.04		*	3.780	11.335	

Figures with same alphabets did not differ significantly. ** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant. Values were compared with respective C.D values. M_1 - Black polythene mulch, M_2 - Organic mulch and M_0 - Without mulch. F_1 - 100% RDF, F_2 - 75% RDF and F_3 - 50% RDF.

Table 3: Effect of mulching and fertigation on bunch weight (kg) of banana cv. Grandnaine

Bunch weight (kg)																
Year	**2017-2018**				**2018-2019**				**2019-2020**				**Pooled**			
Treatments	**Mulches**				**Mulches**				**Mulches**				**Mulches**			
Fertigation	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**
F_1	22.47^{c}	24.60^{a}	20.60^{d}	22.55^{a}	21.33^{a}	20.22^{b}	20.10^{b}	20.55^{a}	20.45^{a}	19.45^{c}	19.33^{c}	19.74^{a}	21.41^{a}	21.42^{a}	20.01^{a}	20.94^{a}
F_2	20.40^{d}	23.43^{b}	19.40^{e}	21.07^{b}	20.10^{b}	19.45^{c}	18.45^{f}	19.33^{b}	19.66^{b}	18.50^{d}	18.00^{e}	18.72^{b}	20.05^{a}	20.46^{a}	18.61^{b}	19.70^{b}
F_3	18.63^{f}	20.33^{d}	17.43^{g}	18.79^{c}	19.22^{d}	18.68^{e}	16.22^{g}	18.04^{c}	18.33^{d}	17.33^{f}	15.68^{g}	17.11^{c}	18.72^{b}	18.78^{b}	16.44^{c}	17.98^{c}
Mean	20.50^{b}	22.78^{a}	19.14^{c}		20.21^{a}	19.45^{b}	18.25^{c}		19.48^{a}	18.42^{b}	17.67^{c}		20.06^{a}	20.22^{a}	18.35^{b}	
	F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±		CD at (5%)
Factor F	*	0.08	0.25		*	0.038	0.116		*	0.033	0.099		*	0.289		0.868
Factor M	*	0.08	0.25		*	0.038	0.116		*	0.033	0.099		*	0.289		0.868
F×M	*	0.14	0.43		*	0.067	0.201		*	0.057	0.173		*	0.501		1.504

Figures with same alphabets did not differ significantly. ** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant. Values were compared with respective C.D values. M_1 - Black polythene mulch, M_2 - Organic mulch and M_0 - Without mulch. F_1 - 100% RDF, F_2 - 75% RDF and F_3 - 50% RDF.

Table 4: Effect of mulching and fertigation on yield (t/ha) of banana cv. Grandnaine

Yield (t/ha)																
Year	**2017-2018**				**2018-2019**				**2019-2020**				**Pooled**			
Treatments	**Mulches**				**Mulches**				**Mulches**				**Mulches**			
Fertigation	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**
F_1	55.48^{c}	60.74^{a}	50.86^{d}	55.69^{a}	52.65^{a}	49.91^{b}	49.62^{b}	50.72^{a}	50.49^{a}	48.02^{b}	47.72^{b}	48.74^{a}	52.87^{a}	52.89^{a}	49.40^{b}	51.72^{a}
F_2	50.37^{d}	57.85^{b}	47.90^{e}	52.04^{b}	49.62^{b}	48.01^{c}	45.54^{f}	47.72^{b}	48.54^{b}	45.67^{c}	44.44^{c}	46.21^{b}	49.51^{b}	50.51^{a}	45.96^{c}	48.66^{b}
F_3	45.99^{f}	50.19^{d}	43.03^{g}	46.40^{c}	47.45^{d}	46.11^{e}	40.04^{g}	44.53^{c}	45.25^{c}	42.78^{d}	38.71^{e}	42.24^{c}	46.23^{c}	46.36^{c}	40.59^{d}	44.39^{c}
Mean	50.61^{b}	56.26^{a}	47.26^{c}		49.90^{a}	48.01^{b}	45.06^{c}		48.09^{a}	45.49^{b}	43.62^{c}		49.53^{a}	49.92^{a}	45.31^{b}	
	F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)	
Factor F	*	0.133	0.398		*	0.05	0.17		*	0.331	0.995		*	0.576	1.727	

Factor M	*	0.133	0.398	*	0.05	0.17	*	0.331	0.995	*	0.576	1.727
F×M	*	0.230	0.691	*	0.10	0.31	*	0.574	1.724	*	0.998	2.992

Figures with same alphabets did not differ significantly. ** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant. Values were compared with respective C.D values. M_1 - Black polythene mulch, M_2 - Organic mulch and M_0 - Without mulch. F_1 - 100% RDF, F_2 - 75% RDF and F_3 - 50% RDF.

Table 5: Effect of mulching and fertigation on TSS (^{0}Brix) of banana cv. Grandnaine

TSS (^{0}Brix)																
Year	**2017-2018**				**2018-2019**				**2019-2020**				**Pooled**			
Treatments	**Mulches**				**Mulches**				**Mulches**				**Mulches**			
Fertigation	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**
F_1	22.30	23.60	22.10	22.66	22.10	22.50	23.70	22.76	22.45	22.75	22.55	22.58	22.28	22.95	22.78	22.67
F_2	23.10	22.20	21.00	22.10	20.30	21.80	20.50	20.86	19.85	21.40	21.66	20.97	21.08	21.80	21.05	21.31
F_3	21.40	21.60	21.27	21.42	20.80	21.00	21.60	21.13	20.60	20.35	20.90	20.61	20.93	20.98	21.25	21.05
Mean	22.26	22.46	21.45		21.06	21.76	21.93		20.96	21.50	21.70		21.43	21.91	21.69	
	F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)	
Factor F	*	0.11	0.35		*	0.02	0.08		*	0.024	0.073		*	0.243	0.728	
Factor M	*	0.11	0.35		*	0.02	0.08		*	0.024	0.073		*	0.243	NS	
F×M	*	0.20	0.61		*	0.05	0.15		*	0.042	0.126		*	0.421	NS	

Figures with same alphabets did not differ significantly. ** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant. Values were compared with respective C.D values. M_1 - Black polythene mulch, M_2 - Organic mulch and M_0 - Without mulch. F_1 - 100% RDF, F_2 - 75% RDF and F_3 - 50% RDF.

Table 6: Effect of mulching and fertigation on shelf life (Days) of banana cv. Grandnaine

Shelf life (Days)																
Year	**2017-2018**				**2018-2019**				**2019-2020**				**Pooled**			
Treatments	**Mulches**				**Mulches**				**Mulches**				**Mulches**			
Fertigation	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**	**M_1**	**M_2**	**M_0**	**Mean**
F_1	11.70	12.50	10.53	11.57	11.26	11.20	10.22	10.89	11.10	11.00	10.55	10.88	11.35	11.56	10.43	11.11
F_2	10.71	11.37	11.45	11.17	10.44	11.13	11.10	10.89	10.75	11.88	11.45	11.36	10.63	11.46	11.33	11.14
F_3	10.67	9.60	10.47	10.24	11.55	9.85	10.65	10.68	10.50	9.33	10.30	10.04	10.90	9.59	10.47	10.32
Mean	11.02	11.15	10.81		11.08	10.72	10.65		10.78	10.73	10.76		10.96	10.87	10.74	
	F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)		F -Test	S.Em±	CD at (5%)	
Factor F	*	0.08	0.25		*	0.015	0.044		*	0.017	0.051		*	0.133	0.401	
Factor M	*	0.08	0.25		*	0.015	0.044		*	0.017	NS		*	0.133	NS	
F×M	*	0.14	0.42		*	0.025	0.078		*	0.029	0.089		*	0.231	0.695	

Figures with same alphabets did not differ significantly. ** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant. Values were compared with respective C.D values. M_1 - Black polythene mulch, M_2 - Organic mulch and M_0 - Without mulch. F_1 - 100% RDF, F_2 - 75% RDF and F_3 - 50% RDF.

Quality parameters

The data on TSS (^{0}Brix) presented in the table 5 infers that, there was no significant difference among mulching materials and interaction treatments. However, fertigation doses significantly influenced the TSS (^{0}Brix) (Table 5) under present study. The maximum TSS was recorded with 100% RDF (F_1) (22.67 ^{0}Brix) which was followed by 75% RDF (F_2) (21.31 ^{0}Brix) and 50% RDF (F_3) (21.05 ^{0}Brix) treatments. This might be due to the increased level of potassium with higher dose of fertilizers application leads to increased translocation of carbohydrates from leaves to fruit favoured the conversion of sugars to starch when photosynthates reach the fruit. The similar increase in TSS of fruits with higher dose of fertilizers application was earlier reported by Sindhupriya *et al*. (2018) [17] in Nandren banana and Hanuman N.M *et al*., (2016a) [4] in banana cv.Grand naine. The results on effect of mulching and fertigation on shelf life (days) was presented in the table 6. The data revealed that there is no significant difference among mulching material with respect to shelf life (days). However, fertigation doses significantly influenced the shelf life (days) (Table 5)

Under present study. The maximum shelf life was recorded with 75% RDF (F_2) (11.14 days) which was at par with 100% RDF (F_1) (11.11 days) and minimum shelf life (days) was recorded in 50% RDF (F_3) (10.32 days) treatment. Among interactions maximum shelf life recorded in organic mulch along with 100% RDF (M_2F_1) (11.56 days) which was at par with organic mulch along with 75% RDF (M_2F_2) (11.46 days), black polythene mulch along with 100% RDF (M_1F_1) (11.35 days), without mulch along with 75% RDF (M_0F_2) (11.33 days) and black polythene mulch along with 50% RDF (M_1F_3) (10.90 days) and minimum shelf life was recorded in organic mulch along with 50% RDF (M_2F_3) (9.59 days). The maximum shelf life with higher dose of fertilizers may be due to more synthesis of photoassimilates and better accumulation of starch compounds in the fruits compared to remaining treatments. This higher accumulated sugars and acids might have acted as substrates for respiration during storage and enhanced storage life. The similar enhancement in shelf life with higher dose of fertilizers application was earlier confirmed with Sindhupriya *et al*. (2018) [17] in Nandren banana and Hanuman N.M *et al*., (2016b) [5] in banana cv.Grand naine.

Conclusion

Based on the above results, it can be concluded that, organic mulch (M_2) with 100% RDF (F_1) followed by black polythene mulch (M_1) with 100% RDF (F_1) was found to be best for cv. Grand naine to get higher yields under Telangana conditions.

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