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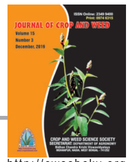

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Effect of land configurations, genotypes and mulching on growth parameters and yield of yellow pericarp sorghum under rainfeed conditions

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ABSTRACT

A field experiment was conducted during kharif, 2018-19 at College of Agriculture, PJTSAU, Rajendranagar, Hyderabad to study the effect of land configurations, genotypes and mulching on growth parameters and yield of yellow pericarp sorghum under rainfed conditions in sandy clay loam soil.The treatments included land configurations viz., Flat bed, Ridge and furrow, Broad bed and furrow, Flat bed + Mulch, Ridge and Furrow + Mulch, Broad bed and furrow + Mulch and yellow sorghum genotypes viz., Palem yellow pericarp sorghum(PYPS) 101,102, 103 and 104. Pongamia leaves were applied as mulch @ 6 t ha^{-1} uniformly at 20 DAS. The results of the present investigation showed that different land configurations and genotypes significantly increased growth parameters and yield. But the interaction between land configurations and genotypes was found to be non-significant.Yellow sorghum under broad beds and furrows with mulch recorded significantly higher grain yield (1701 kg ha^{-1}) resulting in increased yield by 37 % of yellow sorghum over flatbed. Ridges and furrow with mulch was found to be the second-best treatment, with a grain yield of 1590 kg ha^{-1}. Mulched treatments of flat bed, ridge and furrow and broad bed and furrow increased the grain yield by 20%, 28% and 37%, respectively, compared to flatbed without mulch. Correspondingly, Palem yellow pericarp sorghum 102 recorded significantly higher grain yield (1585 kg ha^{-1}). However, it was on par with PYPS 103 (1508 kg ha^{-1}). Broad bed and furrow with mulch was most effective in achieving higher plant height, leaf area, leaf area index (LAI), dry matter production (DMP) followed by ridges and furrows with mulch. Similarly,Palem yellow pericarp sorghum 102 genotype showed significantly higher potential with respect to all growth parameters and yield, closely followed by Palem yellow pericarp sorghum 103.

Keywords: Broad bed and furrow, genotypes, pongamia mulch, ridges and furrow, yellow pericarp sorghum.

Sorghum is mainly produced and consumed by rural poor in and around the world. It is one of the main staple foods for world's poorest and most food insecure people across semi-arid tropics. It is one among the five major cereals in India and contributes to about 16% of the world's sorghum production. In India, sorghum is grown in 5.65 million hectares with a production of 4.41 million tonnes and the average yield is 780 kg ha^{-1} (Agricultural Statistics at a Glance, 2016). In Telangana, it is cultivated in 80,000 ha with production of 70,000 tonnes and productivity of 1051 kg ha^{-1}. Out of the total cultivated area under sorghum in Telangana, 60 % accounted to 48,000 ha is under rainfed conditions. However, area under sorghum is declining every year (from 18 million ha in 1960 to 5.65 million ha in 2015-16) in all parts of India.Various reasons for declining area are technological (hybrid varieties, input supply), qualitative (grain mold, colour, *etc*.), economic (price, demand, supply *etc*.) and storage factors. Hence, an alternate use of sorghum is the need of the hour to improve socio-economic conditions of the farmers.Yellow sorghums are typically tall statured, low yielding local land races. These are generally raised in patches in tribal areas of Telangana during *kharif* for subsistence with minimum management practices, resulting in low yields and susceptibility to pests and diseases. However, high nutritional, good *roti* making and keeping qualities of yellow sorghum are creating demand for increase in its area and production with improved cultures.

The productivity of any crop is a complex phenomenon and influenced by various factors *viz*., use of improved genotypes, prudent use of water as well as nutrients, proper time and method of sowing, and other management practices. However, appropriate agronomic management practices like suitable land configuration and regulated water usage are the most critical factors for realizing desired yield potential with higher resource use efficiency (Deshmukh *et al*., 2016). The use of surface organic mulch helps to store more precipitation water in soil by reducing runoff, increasing infiltration, decreasing evaporation and also has an impact on the crop growth by influencing the soil moisture availability.

Presently, yellow sorghum genotypes with higher productivity were identified at Regional Agricultural Research Station, Palem, Telangana. The objectives of the experiment are to evaluate the influence of land configurations and genotypes on growth parameters, yield of yellow pericarp sorghum and also to assess the performance of yellow sorghum genotypes under different land configurations and mulching.

Short communication

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A field study was performed at College of Agriculture, PJTSAU, Rajendranagar, Hyderabad during *kharif* of 2018. Perusal of the data revealed that the soil was classified under sandy clay loam textural class, with neutral reaction (6.83), low (0.46 %) organic carbon, low (224 kg ha^{-1}) available nitrogen, medium (37.2 kg ha^{-1}) available phosphorus and high (467.6 kg ha^{-1}) available potassium. The bulk density of 0-15 cm and 15-30 cm was 1.48 g $c.c^{-1}$ and 1.58 g $c.c^{-1}$ respectively. The soil moisture content in 0-15 cm and 15-30 cm depth at field capacity was 19.2 and 17.8 per cent respectively and at permanent wilting point were 8.7 and 7.5 per cent respectively. The total rainfall received during the growth period was 333.8 mm in 21 rainy days.

The treatments comprising of six land configurations as main plots and four yellow sorghum genotypes as sub plots were laid out in strip plot design and replicated thrice. Main plots included Flat bed, Ridge and furrow, Broad bed and furrow, Flat bed + Mulch, Ridge and Furrow + Mulch, Broad bed and furrow + Mulch. Mulch applied was pongamia leaf @ 6 t ha^{-1}. Sub plots included Palem Yellow Pericarp Sorghum (PYPS) 101, PYPS 102, PYPS 103 and PYPS 104. The net plot area was 4.05 x 4.2 m and the genotypes were sown at recommended spacing of 45 × 15 cm. Green leaf of pongamia, used as mulch was spread between the crop rows in uniform thickness at 20 DAS. The crop was sown on 5.07.2018 and harvested on 22.10.2018.

Broad beds and furrows were laid with a bed width of 135 cm and 15 cm deep furrow. Similarly, 15 cm deep furrows were laid out for ridges and furrows. Good care was taken to maintain same number of crop rows (12 rows) and total nunber of plants throughout the growing period in each configuration. Urea, DAP and MOP were used as sources at recommended dosages of 60:40:30 kg N: P_2O_5: K_2O ha^{-1}. The recommended dose of nitrogen @ 60 kg $ha^{-1}$was applied as a uniform dose in two splits, one as basal and the other at 30 DAS. Entire dose phosphorus (40 kg ha^{-1}) and potash (30 kg ha^{-1}) were applied at the time of sowing uniformly to all the plots.Soil moisture was estimated from two soil depths *viz.,* 0-15 and15-30 cm by gravimetric method at weekly intervals.

Leaf area per plant was estimated from five randomly selected plants in gross plot sampled by destructive method at 30, 60 DAS and at harvest using leaf area meter (Model Li-300 from Licor Co Nebraska). Leaf area index was calculated by dividing leaf area with the corresponding land area as suggested by Watson (1952).

LAI = Leaf area $plant^{-1}(cm^2)$/Spacing (cm^2)

The experimental data were subjected to statistical analysis following the procedure for strip-plot design as outlined by Panse and Sukhatme (1978). The significance was tested by 'F' test at 5 per cent level of probability (Snedecor and Cochron, 1967). Critical differences were worked out for the effects which were significant.

The data revealed that land configurations and genotypes significantly influenced growth parameters and yield of yellow sorghum, whereas the interaction effect was insignificant.

Among land management practices, significantly higher plant height was observed with broad bed and furrow + mulch (287cm)(Table1) at harvest.Better availability of soil moisture and proper root aeration with broad beds and furrows method might have favoured cell elongation and division leading to higher plant height (Halli and Angadi, 2017). However, at 60 DAS, broad bed and furrow with mulch was found to be at par with ridges and furrow with mulch. This might be due to greater utilization of available soil moisture during the peak growth period (60 DAS) by both the mulched treatments.The superiority of broad beds and furrows in improving the growth in terms of plant height was also demonstrated by several researchers like Joshi *et al*. (2018); and Jnanesha *et al*. (2016). Conversely, shortest plants of yellow sorghum at harvest were observed in flat bed without any mulch (253 cm) (Table 1).

Among genotypes PYPS 102, at 60 DAS (258 cm) and harvest (280 cm)(Table 1), was at par with PYPS 103 (60 DAS - 251 cm and at harvest - 273 cm) (Table 1)with comparable plant heights. The results are in conformity with Patil and Ramesha (2016). However, PYPS 101 recorded lowest plant height (60 DAS - 236 cm and at harvest - 257 cm)(Table 1).

Broad bed and furrow with mulch recorded higher leaf area $plant^{-1}$ (3122cm^2 $plant^{-1}$) and remained at par with both ridges and furrows with mulch (3019 cm^2 $plant^{-1}$) and flat bed with mulch at 60 DAS (2928 cm^2 $plant^{-1}$) (Table 2), whereas at harvest, broad bed and furrow with mulch (M_6) and ridges and furrows with mulch (M_5) were at par recorded leaf area of 1504 and 1448 cm^2 $plant^{-1}$, respectively. Favorable moisture regime due to land management along with mulch throughout the crop growth period has increased the internodal length as seen by taller plants (Table 1) and helped in exertion of more number of leaves in mulched treatments. More leafiness in these treatments in turn had putforth more leaf area per plant.

The genotype PYPS 102 owing to more number of leaves per plant, had registered significantly higher leaf area per plant at harvest (1418 cm^2 $plant^{-1}$) (Table 2). However, PYPS 103 with a leaf area of 1362 cm^2 $plant^{-1}$ was found to be at par with PYPS 102 at harvest. On a lower note, PYPS 101 had recorded least leaf area per plant (1068cm^2 $plant^{-1}$) (Table 2) in comparison to

Table 1: Influence of land configuration, genotypes and mulching on plant height of yellow sorghum

Treatments	Plant height (cm)		
	30 DAS	60 DAS	At Harvest
Main plots			
M_1 -Flatbed (FB)	34.1^{f}	216^{e}	253^{d}
M_2 -Ridge and furrow (RF)	35.8^{e}	228^{d}	262^{c}
M_3 -Broad Bed and Furrow (BBF)	38.1^{d}	241^{c}	264^{c}
M_4 -FB + M	39.0^{c}	252^{b}	269^{bc}
M_5 -RF + M	40.7^{b}	268^{a}	276^{b}
M_6 -BBF + M	43.1^{a}	276^{a}	287^{a}
SEm (±)	**0.3**	**5**	**4**
LSD (0.05)	**0.6**	**7**	**8**
Sub plots			
S_1 – PYPS 101	36.0^{d}	236^{c}	257^{c}
S_2 – PYPS 102	41.4^{a}	258^{a}	280^{a}
S_3 – PYPS 103	39.2^{b}	251^{ab}	273^{a}
S_4 – PYPS 104	37.4^{c}	244^{bc}	266^{b}
SEm (±)	**0.4**	**3.5**	**2.5**
LSD (0.05)	**0.9**	**8.5**	**5.3**
Interaction (Main x Sub)			
SEm (±)	**0.6**	**2.7**	**6.3**
LSD (0.05)	**NS**	**NS**	**NS**
Interaction (Sub xMain)			
SEm (±)	**0.41**	**5.32**	**6.5**
LSD (0.05)	**NS**	**NS**	**NS**

PYPS *– Palem yellow pericarp sorghum,* ***M*** *– Pongamia mulch @ 6 t ha*$^{-1}$

Table 2: Influence of land configuration, genotypes and mulching on leaf area of yellow sorghum

Treatments	Leaf area (cm^2)		
	30 DAS	60 DAS	At Harvest
Main plots			
M_1 -Flatbed (FB)	1159^{e}	2722^{d}	968^{d}
M_2 -Ridge and furrow (RF)	1290^{d}	2777^{c}	1075^{cd}
M_3 -Broad Bed and Furrow (BBF)	1412^{c}	2829^{c}	1184^{c}
M_4 -FB + M	1416^{c}	2928^{b}	1342^{b}
M_5 -RF + M	1512^{b}	3019^{b}	1448^{ab}
M_6 -BBF + M	1663^{a}	3122^{a}	1504^{a}
SEm (±)	**38**	**41**	**55**
LSD (0.05)	**84**	**92**	**122**
Sub plots			
S_1 – PYPS 101	1255^{d}	2850	1068^{c}
S_2 – PYPS 102	1632^{a}	2948	1418^{a}
S_3 – PYPS 103	1446^{b}	2913	1362^{a}
S_4 – PYPS 104	1303^{c}	2887	1166^{b}
SEm (±)	**17**	**9**	**25**
LSD (0.05)	**42**	**NS**	**61**
Interaction (Main x Sub)			
SEm (±)	**53**	**25**	**71**
LSD (0.05)	**NS**	**NS**	**NS**
Interaction (Sub x Main)			
SEm (±)	**49**	**26**	**82**
LSD (0.05)	**NS**	**NS**	**NS**

PYPS*-Palem yellow pericarp sorghum,* ***M*** *– Pongamia mulch @ 6 t ha*$^{-1}$

the other genotypes. Improved performance of the crop on raised beds with improved varieties was also mentioned by Patel *et al*. (2015) with respect to sorghum and chickpea, respectively.

Similar to leaf area, broad bed and furrow with mulch recorded higher LAI (2.22) (Table 3) and was at par with ridges and furrows with mulch (2.14) (Table 3) at harvest. More leaf number and leaf area has contributed to higher LAI under broad bed and furrows, ridges and furrows over flat bed which was also mentioned by Patel *et al*. (2015), Jnanesha *et al*. (2016), Halli and Angadi (2017) and Shinde *et al*. (2012)

Maximum LAI (2.10) (Table 3) was registered by PYPS 102 which was comparable to PYPS 103 with equivalent LAI value (2.01) (Table 3) at harvest. Lowest LAI (1.58) (Tab. 3) was registered by PYPS 101 at harvest which is obvious with lowest leaf area recorded.

Total DMP of yellow sorghum was significantly higher in the crop raised on broad beds and furrows with mulch at harvest (13988 kg ha^{-1}) (Table 4). The best performance of this treatment is resultant of significantly taller plants with highest leaf area and hence greater assimilation of photosynthates. Jnanesha *et al.* (2016) also opined that higher availability of moisture and nutrients in broad bed and furrow might had resulted in the higher nutrient uptake which might have accelerated the dry matter production in leaves. The lowest dry matter production conversely was noted with the crop raised on flat beds without mulch (11554 kg ha^{-1}) at harvest (Table 4).

Among the genotypes, PYPS 102 stood best with highest dry matter production (13791 kg ha^{-1}) (Table 4) at harvest, while PYPS 101 registered lower dry matter production (11838 kg ha^{-1}) (Table 4).

Among land configurations broad bed and furrow with mulch recorded significantly higher grain yield (1701 kg ha^{-1}) (Table 5). Higher growth parameters led by dry matter accumulation and yield attributes in broad

Table 3: Influence of land configuration, genotypes and mulching on leaf Area Index of yellow sorghum

Treatments	Leaf area index		
	30 DAS	60 DAS	At Harvest
Main plots			
M_1 -Flatbed (FB)	1.71[e]	4.03[e]	1.43[d]
M_2 -Ridge and furrow (RF)	1.91[d]	4.11[de]	1.60[cd]
M_3 -Broad Bed and Furrow (BBF)	2.09[c]	4.20[d]	1.75[c]
M_4 -FB + M	2.09[c]	4.33[c]	1.98[b]
M_5 -RF + M	2.24[b]	4.50[b]	2.14[ab]
M_6 -BBF + M	2.50a	4.62[a]	2.22[a]
SEm (±)	**0.06**	**0.06**	**0.08**
LSD (0.05)	**0.12**	**0.09**	**0.18**
Sub plots			
S_1 – PYPS 101	1.86[d]	4.22	1.58[c]
S_2 – PYPS 102	2.41[a]	4.36	2.10[a]
S_3 – PYPS 103	2.14[b]	4.31	2.01[a]
S_4 – PYPS 104	1.93[c]	4.27	1.72[b]
SEm (±)	**0.02**	**0.01**	**0.04**
LSD (0.05)	**0.05**	**NS**	**0.09**
Interaction (Main x Sub)			
SEm (±)	**0.08**	**0.04**	**0.11**
LSD (0.05)	**NS**	**NS**	**NS**
Interaction (Sub x Main)			
SEm (±)	**0.06**	**0.05**	**0.13**
LSD (0.05)	**NS**	**NS**	**NS**

***PYPS** – Palem yellow pericarp sorghum, **M** – Pongamia mulch @ 6 t ha^{-1}*

Table 4: Influence of land configuration, genotypes and mulching on dry matter production of yellow sorghum

Treatments	Dry matter production (kg ha^{-1})		
	30 DAS	60 DAS	At harvest
Main plots			
M_1 -Flatbed (FB)	1214[f]	5591[d]	11554[d]
M_2 -Ridge and furrow (RF)	1402[e]	6025[d]	11913[cd]
M_3 -Broad Bed and Furrow (BBF)	1541[d]	6720[c]	12610[bc]
M_4 -FB + M	1636[c]	6882[c]	13109[ab]
M_5 -RF + M	1776[b]	7579[b]	13460[ab]
M_6 -BBF + M	1929[a]	8263[a]	13988[a]
SEm (±)	**36**	**230**	**460**
LSD (0.05)	**80**	**512**	**1025**
Sub plots			
S_1 – PYPS 101	1408[d]	6308[c]	11838[c]
S_2 – PYPS 102	1742[a]	7559[a]	13791[a]
S_3 – PYPS 103	1616[b]	6863[b]	12949[b]
S_4 – PYPS 104	1566[c]	6643[bc]	12510[bc]
SEm (±)	**14**	**168**	**336**
LSD (0.05)	**35**	**411**	**822**
Interaction (Main xSub)			
SEm (±)	**34**	**547**	**1094**
LSD (0.05)	**NS**	**NS**	**NS**
Interaction (SubxMain)			
SEm (±)	**47**	**526**	**1053**
LSD (0.05)	**NS**	**NS**	**NS**

***PYPS**– Palem yellow pericarp sorghum, **M**– Pongamia mulch @ 6 t ha^{-1}*

beds and furrows with mulch contributed to higher grain yield. Srivatsava and Jangawad (1998) also reported higher yields with broad bed and furrow method of planting in soybean which might had helped in *in-situ* moisture conservation, improved root growth and better nutrient access thus increasing the grain yield. Further, the leaf mulch might have benefitted the crop by increasing the infiltration rate, fertilizer accessibility and hence resulting in increased yields (Dushouyu *et al.,* 1995). Distinctively lower grain yield of 1239 kg ha^{-1} was noticed under flat bed with no mulch (M_1). Ridges and furrows with no mulch (M_2) also was found on par to M_1 with equivalently lower yield of 1312 kg ha^{-1}.

PYPS 102 (1585 kg ha^{-1}) and PYPS 103 (1507kg ha^{-1}) (Table 5) fared equivalently well to register higher grain yield among the genotypes, whereas PYPS 104 and PYPS 101 recorded lower grain yields (PYPS 104- 1413 kg ha^{-1}and PYPS 102- 1320 kg ha^{-1}) (Table 5).

A perusal of the data indicated that stover yields were comparable and higher in broad beds and furrows with mulch (M_6) and ridges and furrows with mulch (M_5) (12403 and 11965 kg ha^{-1}, respectively) (Table 5). This might be attributed to enhancement in moisture content at different soil depths (0-15 cm and 15-30 cm) at various crop growth stages. These results are in accordance with findings of Jnanesha *et al.,* (2016) and Halli and Angadi (2018). On the other hand, flatbed (M_1), ridges and furrows (M_2) and broad beds and furrows (M_3) without mulch registered lower stover yields of 10178, 10319 and 10583 kg ha^{-1}, respectively.

Among genotypes, PYPS 102 with significantly higher stover yield of 12085 kg ha^{-1} out performed other genotypes, whereas PYPS 101 was noted to be the least (10151 kg ha^{-1}) (Table 5) with regards to stover yield.

Table 5: Influence of land configuration, genotypes and mulching on grain and stover yield

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Main plots		
M_1 -Flatbed (FB)	1239^{e}	10178^{c}
M_2 -Ridge and furrow (RF)	1312^{de}	10319^{c}
M_3 -Broad Bed and Furrow (BBF)		1406^{cd}
10583^{c}		
M_4 -FB + M	1491^{bc}	11576^{b}
M_5 -RF + M	1590^{b}	11965^{ab}
M_6 -BBF + M	1701^{a}	12403^{a}
SEm (±)	**47**	**219**
LSD (0.05)	**105**	**487**
Sub plots		
S_1 – PYPS 101	1320^{c}	10151^{d}
S_2 – PYPS 102	1585^{a}	12085^{a}
S_3 – PYPS 103	1507^{ab}	11579^{b}
S_4 – PYPS 104	1413^{bc}	10869^{c}
SEm (±)	**45**	**144**
LSD (0.05)	**109**	**353**
Interaction (Main xSub)		
SEm (±)	**47**	**348**
LSD (0.05)	**NS**	**NS**
Interaction (SubxMain)		
SEm (±)	**63**	**373**
LSD (0.05)	**NS**	**NS**

***PYPS** – Palem yellow pericarp sorghum, **M**-Pongamia mulch @ 6 t ha^{-1}*

From this investigation, it can be inferred that yield enhancement of yellow sorghum is possible through proper land management practices and by using region specific genotype. Broad beds and furrows with addition of mulch (BBF + M) resulted in improved growth attributes and yield of yellow sorghum. However, ridges and furrows with addition of mulch was also observed to be on parity to BBF + M for certain growth and yield parameters. Among the genotypes PYPS 102 showed higher potential with respect to growth and yield. PYPS 103, closely followed the above genotype.

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