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Parsoon Singh
Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Sumit Kumar Gupta
Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Pradip Kumar Saini
Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Dr. B Mehera
Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Correspondence
Parsoon Singh
Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Effect of microclimatic modification on the growth and yield of transplanted rice (*Oryza sativa* L.)

Parsoon Singh, Sumit Kumar Gupta, Pradip Kumar Saini and Dr. B Mehera

Abstract
A field experiment was conducted during *kharif* season in the year 2015-16 on rice at Agro-meteorological research farm of Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad. The experiment consisted of four replication and nine treatment combinations comprised of three planting geometry *viz*., Godavari-Ganga-Boss, SHIATS-Dhan-1 and Arise-6444-Gold. Results revealed that planting geometry at 20x10cm produced significantly higher growth yield attributes and yield due to fulfilment of optimum planting population, thermal requirement and solar light requirement for various plant processes. The highest thermal use efficiency was recorded when sowing was done on 20x15cm planting geometry followed by 20x10cm spacing, Arise-6444 Gold recorded highest thermal use efficiency at all the stages. The interaction between microclimatic modification and varieties was found non-significant and thermal unit of (21650 days), from sowing to maturity produced the highest yield of rice variety Shiats-Dhan1.

Keywords: Rice, growth and yield

Introduction
Rice (*Oryza sativa* L.) belong to the family Gramineae, genus Oryza and has two cultivated and 22 wild species. The cultivated species are *Oryza sativa* and *Oryza glaberrima*. *Oryaza* is grown all over the world while, *Oryza glaberrima* been cultivated in West Africa for the last 3500 years. Rice is believed to have evolved around 130 million years ago. It is only considered to have been cultivated within the last nine thousand years. Rice is grown under many different condition. Rice is the only cereal crop the can grow for long periods of time in standing water 57%of rice is grow on irrigated land, 25%on rain fed lowland, 10% on the uplands, 6% in deep water, and 2% in tidal wetlands. Rice is one of the most important cereal crop belong to the family Graminae. It is the staple food for half of the world`s populations. Rice is cultivated of worldwide in area of 156.80 million hectare having an annual production of 650.19 million tonne (Anonymous, 2010). In the latest report, the International Grains Council has projected India`s rice production to touch a new record at 107 million tonnes in 2013-14 and area planted under rice has increased to 46.00 million hectare. In Uttar Pradesh it is grown in about 5.90m ha which comprises of 13.5% of total rice in India (Anonymous, 2010-2011). Among the rice growing countries, India stands first in area and second in production next only to China. To assess the response of prevailing environment and their interaction with photosensitive genotypes (Mahsoori) and photo insensitive (Ashwani and pant-4), a field experiment was conducted under semiarid condition of Kanpur. This study proved that the year (1998) was more favourable for growth and development and by virtue of this year crops produced more biomass, it might be to conducive environmental condition during vegetative phase and vice versa for reproductive phase. The variation in plating geometry cause the change in microclimatic modification, thermal requirement and radiation received by the crop canopy. The bio-chemical process leading the growth and development of plant is governed by thermal as well as radiation received by the crop canopy and ultimately yield varied under variable microclimatic condition. Rice yield depends also on variable microclimatic modification through planting geometry, Congenial microclimatic condition enhance the yield of rice cultivars and environmental resource sustainability in the area.

Material and Methods

The experiments consist of 9 treatment combinations, which comprised of three rice varieties (Godavari-Ganga-Boss, SHIATS-DHAN-1, Arise-6444 Gold) and three planting geometry, were grown during *Kharif* 2015-16 in SPD and replicated four time, at the Agro meteorological Research farm, Sam Higginbottom Institute of Agriculture Technology & Science Allahabad. Situated at a 25.57^0 N latitude, 81.51''E longitude and at altitude of 98 meter above sea level, Allahabad receives the mean annual rainfall ranges 886mm. More than70% rains received during S-W monsoon season 5-10% rains are received in winter. The observations were recorded on the, Growth parameters, *viz.* Plant height (cm), Leaf area index, No. of shoot per hill, Dry matter accumulation and yields parameters *viz.* No. of panicles per hill, Length of panicle, No. of grains panicle, No. of filled grains per panicle, Test weight (g), Grain yield (kg per ha), Straw yield (kg per ha), Harvest index (%)

Result and Discussion

Plant height (cm)

Plant height of different varieties of rice and plant geometry is presented in Table 1. Plant height increased with the advancement of the crop growth upto 90 DAT in all the three varieties. The maximum plant height (44.2, 75.1 and 117.6cm) was recorded with plant geometry of 20x10cm while maximum(42.5, 68.9 and 105.0cm) in plant geometry of 20x20cm at 30, 60, and 90 days after transplanting of crop growth. The maximum plant height (32.8, 54.3 and 84.1cm) was recorded with Arise-6444 Gold at 30, 60 and 90DAT. Which was significantly superior to Godavari-Ganga-Boss and SHIATS-DHAN-1 at all growth stage. Anchal *et. al.* (2012) observed that wider spacing (25x25) under SRI recorded significantly taller plant than the closer spacing (20x20cm). Plant get sufficient space above the ground (shoot) and below the ground (root) to grow which increased the light transmission in the canopy, leading to grater plant height and my results also corroborated to this.

Table 1: Plant height (cm) of rice as affected by planting geometry and varieties

Treatments	Plant Height (cm)		
	30 DAT	60 DAT	90 DAT
Planting geometry			
20x10cm	44.2	75.1	117.6
20x15cm	42.8	71.1	111.6
20x20cm	44.5	68.9	105.0
SE m±	0.39	0.14	0.15
CD at 5%	0.94	0.35	0.38
Varieties			
Godavari-Ganga-Boss	32.0	53.3	83.0
Shiats-Dhan-1	32.3	53.8	83.6
Arise-6444 Gold	32.8	54.3	84.1
SE m±	0.31	0.16	0.14
CD at 5%	0.62	0.36	0.29

Leaf area index

Data with respect to leaf area index was affected by different varieties and plant spacing of rice have been presented in Table 2. It is quite obvious from the data that the LAI was significantly affected due to planting geometry at all the stage. Significant higher leaf area index (2.3, 5.2 and 4.2 cm) was obtained at planting geometry (20x20cm), while 20x10cm planting geometry indicated lowest LAI (2.1, 4.3 and 3.7cm) at 30, 60 and 90 DAT. Leaf area index was affected significantly at all the stage due to varieties. Higher leaf area index (1.7, 3.6 and 3.0cm) was recorded in Arise-6444 Gold variety. Data also reveal that Godavari-Ganga-Boss variety recorded lowest (1.5, 3.4 and 2.8 cm) leaf area index at 30, 60 and 90 DAT.

Table 2: Leaf area index of rice as affected by planting geometry and varieties

Treatments	Leaf area index		
	30 DAT	60 DAT	90 DAT
Planting geometry			
20x10cm	2.1	4.3	3.7
20x15cm	2.0	4.5	3.7
20x20cm	2.3	5.2	4.2
SE m±	0.02	0.03	0.02
CD at 5%	0.06	0.08	0.05
Varieties			
Godavari-Ganga-Boss	1.5	3.4	2.8
Shiats-Dhan-1	1.6	3.5	2.9
Arise-6444 Gold	1.7	3.6	3.0
SE	0.02	0.04	0.02
CD at 5%	0.05	0.09	0.06

Number of shoots per hill

Data pertaining to Number of shoots per shoots per hill as affected by planting geometry have been presented in Table 3. It is quite obvious from the data that number of shoots per hill was significantly affected due to planting geometry at all the stages. Significantly Number of shoots per hill (10.3, 14.6 and 14.5) was obtained at planting geometry (20x20cm) as compared to that sowing done on 20x15cm planting geometry, 20x10cm planting geometry proved lowest number of shoots per hill at 30, 60 and 90 DAT. Among the varieties revealed that, maximum number of shoots per hill (7.4, 10.2 and 9.9) was recorded in Arise-6444 Gold at 30, 60 and 90 DAT, which was significantly superior to Godavari-Ganga-Boss and SHIATS-DHAN-1. Increase in number of total branches per plant was observed at all stages of crop growth these results also confirmed by the Gill, M. S., Kumar, A. and Kumar, P. (2005) [5]

Table 3: Number of shoots per hill of rice as affected by planting geometry and varieties

Treatments	Number of shoots per hill		
	30 DAT	60 DAT	90 DAT
Planting geometry			
20x10cm	9.5	12.6	12.0
20x15cm	8.3	12.4	12.0
20x20cm	10.3	14.6	14.5
SE m±	0.21	0.20	0.15
CD at 5%	0.52	0.50	0.38
Varieties			
Godavari-Ganga-Boss	6.6	9.5	9.3
Shiats-Dhan-1	7.1	10.0	9.6
Arise-6444 Gold	7.4	10.2	9.9
SE m±	0.14	0.10	0.14
CD at 5%	0.31	0.22	0.31

Dry matter accumulation (g per m^2)

Maximum dry matter accumulation (137.7, 466.2 and 785.6g per m^2) was noticed with plant geometry of 20x10cm at 30, 60 and 90 day after transplanting of crop growth, which was significantly superior over 20x20cm, and at per with 20x15cm of plant geometry. Maximum dry matter accumulation (108.3, 376.3 and 546.8g per m^2) was observed in Arise-6444 Gold at 30, 60 and 90 days after transplanting of crop growth, which

was significantly superior to SHIATS-DHAN-1. Similar results also reported by Hussain, A., Bhat, M.A. and Gaine, M.A. (2012) [6].

Table 4: Dry matter accumulation (g/m^2) of rice as affected by planting geometry and varieties

Treatments	Dry matter accumulation (g per m^2)		
	30 DAT	60 DAT	90 DAT
Planting geometry			
20x10cm	137.7	466.2	785.6
20x15cm	133.6	458.5	701
20x20cm	133.2	449.5	699.6
SE m±	4.07	4.14	0.20
CD at 5%	9.97	10.14	0.49
Varieties			
Godavari-Ganga-Boss	100.8	335.9	546.5
Shiats-Dhan-1	94.3	318.2	546.7
Arise-6444 Gold	108.3	376.5	546.8
SE m±	2.50	7.29	0.19
CD at 5%	5.30	15.45	0.42

Number of panicle per hill

Data with respect to number of panicle per hill was affected by different plant geometry and variety presented in Table 5. The data revealed that maximum number of panicle per hill was recorded with 20x20cm followed by 20x15cm and 20x10cm there was significant difference recorded with planting geometry. The various varieties of rice the highest number of per panicle hill was recorded with Aries-6444 Gold which was significantly superior over the varieties SHIATS-DHAN-1 and Goldawari-Ganga-Boss. Data pertaining to length of panicle presented in Table 5. And that revealed that the maximum length of panicle was observed in 20x20cm which non-significant difference with 20x15cm and 20x10cm. Amo0ng the varieties, Arise-6444 Gold recorded maximum panicle length obtained which was significantly superior over Godawari-Ganga-Boss and SHIATS-DHAN-1.

Length of panicle

Data pertaining to length of panicle presented in Table 5. And that the different planting geometry was obtained. The maximum length of panicle 20x20cm which shows non-significant difference with 20x15cm and 20x10cm. Among the varieties the in Aries-6444 Gold recorded maximum panicle length obtained which was significantly superior over Godavari-Ganga-Boss SHIATS –DHAN-1.

Number of grains per panicle

The number of grains per panicle was also significantly affected with different plant geometry. The maximum number of grains per panicle was recorded in plant geometry of 20x20cm which was recorded non-significant difference with 20x15cm and 20x10cm of planting geometry. The maximum number of grains per panicle was recorded with Arise-6444 Gold, which was significantly superior than SHIATS-DHAN-1 and Godavari-Ganga-Boss. Ella, E. S.*et. al.* (2010) [4],

Number of filled grain per panicle

Data with respect to number of filled grain per panicle as affected by different plant geometry and varieties have been presented in Table 5. Number of filled grain per panicle was also significantly affected with different plant geometry. The maximum number of grains per panicle was recorded with plant geometry of 20x20cm through non-significant. The maximum number of filled grains panicle was recorded with Arise-6444 Gold, which was significantly superior to SHIATS-DHAN-1 and Godavari-Ganga-Boss.

Table 5: Yield attributes of rice as affected by planting geometry and varieties

Treatments	Number of panicles per hill	Length of panicle (cm)	Number of grains per panicle	Number of filled grains per panicle
Planting geometry				
20x10cm	8.4	17.6	142.7	117.6
20x15cm	10.0	18.3	149.3	129.7
20x20cm	9.2	18.0	145.0	121.0
SE m±	0.02	0.02	0.40	0.56
CD at 5%	0.05	0.04	0.36	1.20
Varieties				
Godavari-Ganga-Boss	12.3	23.3	187.8	162.2
Shiats-Dhan-1	12.3	23.7	194.3	163.0
Arise-6444 Gold	12.4	25.0	200.5	163.9
SE m±	0.02	0.06	0.99	0.39
CD at 5%	0.06	0.15	2.42	0.97

Test weight (g)

The various treatment of plant geometry did not significantly influence the test weight (g). The maximum test weight (23.29) was found with 20x10cm followed by 20x15cm, 20x20cm in respect to test weight, Among the different rice varieties the higher test weight (16,27g) was recorded by Arise-6444 Gold which was significantly superior over Godavari-Ganga- Boss and significantly at per with SHIATS-DHAN-1.

Grain yield (q per ha)

Various plant geometry also significantly affected the seed yield of rice. The maximum seed yield was recorded (36.01q) with plant geometry of 20x15cm which was significantly superior over 20x20cm and 20x10cm of plant geometry. The seed yield (39.34q) of rice increased significantly superior to Godavari-Ganga-Boss and SHIATS-DHAN-1. Similar reports were also observed by Chandra, D. *et al*. (1997).

Straw yield (q per ha)

Various plant geometry significantly affected the straw yield of rice. The Straw yield (52.97q) was recorded higher with plant geometry of 20x10cm, which was significantly superior to 20x15cm and 20x20cm of plant geometry. The straw yield (53.97 q) of rice increased significantly with Arise-6444 Gold which was found to be significantly superior than Godavari-Ganga-Boss and SHIATS-DHAN-1. Lee Yuhjyuan *et. al.* (2009) [7]

Harvest index (%)

An examination of data regarding harvest index has been famished in Table 6. The data revealed that, the harvest index was not significantly influences by various treatments of plant geometry and varieties. The maximum harvest index (32.06%) was found with Arise-6444 Gold and plant geometry of 20x10cm. The interaction effect of varieties and plant geometry on harvest index was found significant. Manju Zncharins: Singh, S.; Kumar S. N.; Harit, R. C. and Aggarwal, P. K. (2010) [8]

Table 6: Test weight(g), Grain yield (q per ha), Straw yield (q per ha), Harvest Index (%) of rice as affected by planting geometry and varieties

Treatments	Test weight (g)	Grain yield (q per ha)	Straw yield (q per ha)	Harvest Index (%)
Planting geometry				
20x10cm	23.29	33.94	52.97	38.72
20x15cm	23.47	36.01	52.77	40.13
20x20cm	23.44	34.35	52.73	39.23
SE m±	0.11	0.30	0.36	0.34
CD at 5%	0.29	0.73	0.89	0.83
Varieties				
Godavari-Ganga-Boss	17.84	23.06	41.24	26.89
Shiats-Dhan-1	18.54	15.81	23.63	30.07
Arise-6444 Gold	16.27	39.34	53.97	32.60
SE m±	0.07	0.29	0.36	0.31
CD at 5%	0.15	0.63	0.76	0.66

Conclusion

For the first objective the result may be concluded that the planting geometry at 20x10cm produced significantly higher growth yield attributes and yield due to fulfilment of optimum plant population, thermal requirement and solar light requirement for various plant processes. High temperature during-reproductive stage adversely affected the yield attributes in wider planting geometry (20x20cm) which resulted in the lowest seed yield. Similarly the conclusion for second objective is that the highest thermal use efficiency was recorded when sowing was done on 20x15cm planting geometry followed by 20x10cm spacing and Arise-6444 Gold recorded higher thermal use efficiency at all the stages. For the third objective the results may be concluded that interaction between microclimatic modification and varieties was found non-significant and thermal unit of (2165^0 days), from sowing to maturity produced the highest yield of rice variety Shiats-Dhan1

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