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Growth, physiological behaviour, yield, nutrient uptake and economics of drought tolerant rice (*Oryza sativa* L.) varieties under various crop establishment methods and moisture conservation techniques in sandy loam soils of western U.P

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Abstract
A field experiment was conducted during *kharif* season of 2016 at Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) India to study the performance of drought tolerant rice (*Oryza sativa* L.) varieties under different establishment methods and moisture conservation techniques. Four crop establishment methods (PTR, UPTR, DSR with wheat straw and DSR without wheat straw mulch), three varieties (Sahbhagi, IR 64 and IR 64 drt 1) and two moisture conservation practices (application of pusa hydrogel @ 1.5 kg acre^{-1} and no application) were tested in split-split plot design with 3 replications. Results revealed that the growth parameters viz., plant height, dry matter production, chlorophyll content and yield attributing characters of rice *viz*., panicle length (26.1 cm) and number of filled grains panicle^{-1} (113.2) were significantly higher under PTR rice whereas, the number of effective tillers m^{-2} (227.0) and test weight (22.55 g) was highest under DSR with wheat straw. At the time of harvesting, significantly tallest plants (101.8 cm) were recorded in PTR followed by DSR with wheat straw mulch (94.7 cm), though the shortest plants were recorded under DSR without straw mulch. At harvest, DSR with wheat straw produced 3.8% more rice dry matter m^{-2} than DSR without wheat straw. The PTR rice exhibited 13% more grains yield as compared to DSR with wheat straw whereas, 6.2% more straw yield of rice was recorded under DSR with wheat straw as compared to PTR. The highest total nitrogen (92.0 kg ha^{-1}) and phosphorus (15.0 kg ha^{-1}) uptake was recorded under PTR whereas, the potassium (105.2 kg ha^{-1}) under DSR with wheat straw. The variety IR 64 produced significantly highest dry matter (1115.4 g m^{-2}), effective tillers m^{-2} (207.3), panicle length (25.2 cm), filled grains panicle^{-1} (93.2), test weight (22.41 g), besides 8.0 and 18.6% more grains yieldha^{-1} than Sahbhagi and IR 64 drt 1.The highest nutrient, protein content and total uptake of NPK (11.53, 15.38 and 13.02% more over Sahbhagi, respectively) was recorded under IR 64 which produced 8.1 and 15.7% more gross and net returns than Sahbhagi. The application of pusa hydrogel @ 1.5 kg acre^{-1} over no application at harvest resulted into 4.1, 6.0 and 5.8% more plant height, number of tillers m^{-2} and dry matter production m^{-2}, respectively. This treatment also had significantly (8.1, 5.5 and 5.0%) more total uptake of NPK, respectively, besides higher gross returns ha^{-1}. Among the crop establishment methods, PTR fetched 9.5 and 11.1% more gross and net returns, respectively along with B:C ratio over DSR with wheat straw.

Keywords: establishment methods, net returns, physiological behaviour pusa hydrogel, uptake and yield

Introduction
Rice (*Oryza sativa* L.) is one of the most important cereals and staple food crop of 63 to 65 percent peoples of India, accounts for about 43% of total food grains production and 55% of cereals production in the country, contributes about 20-25% of the Agricultural GDP. Over two billion people in Asia alone derived 80% carbohydrate, 7-8% protein, 3% fat and 3% fiber. Until recently rice was considered only a starch food and a source of carbohydrates and some amount of proteins. Rice is the most important crop in India and is also the hub of food security of the global population. India ranks first in respect of area, second in production only after China, but the productivity of rice is very low. It provides about 21% of the total calorie intake of the world population. Rice is very sensitive to water stress and attempts to reduce water inputs may tax true yield potential. The challenge is to develop novel technologies and production systems that would allow rice production to be maintained or increased at the face

of declining water availability. Increasing food demand and declining water resources are challenges for food security (Kreye *et al*., 2009) [9]. With decreasing water availability, rice production is needed to be switched towards water saving production systems. Rice is primarily grown by transplanting of seedling in puddled field which is very cumbersome and labour intensive and it requires 30 man days ha^{-1} (Prasad, 2004) [16]. Puddeling takes up to 30% of total irrigation water application in rice (Aslam *et al.*2002) [2]. This leads to higher nutrient losses through leaching, besides causing high evapo-transpiration (ET) losses during the hot summer months.Conventional flooded rice receiving the largest amount of fresh water compared to any other crop is the major contributor to the problem of declining ground water table and increasing energy use (Singh *et al.*, 2002)[19].According to the Agricultural Policy Vision 2020 of the Indian Council of Agricultural Research, India has projected a requirement of 112 mt of rice in the year 2020, which is 23 mt more than current rice production hence, to cope with the increasing demand for food, increase in rice yield and production will be required. Rice plant requires large amount of water and mineral nutrients including nitrogen (N) for their growth, development and grain production (Mahajan *et al.,* 2012) [12].

Hydrogel, an indigenous superabsorbent hydrogel technology, has been developed for improving wateruse efficiency of agricultural crops.Wang *et al.* (1990) [22] revealed that hydrogel is a synthetic polymer, which is able to absorb and hold 80-180 times its volume of water for a long time. Under normal conditions drought tolerant rice varieties produces 4-5 t ha^{-1}, whereas other varieties yielded only about 2.5 tonnes, despite the fact that under severe drought conditions, they produces 1-2 t ha^{-1}, while other high-yielding varieties produce nothing at all.Transplanting is the most dominant and traditional method of establishment in irrigated lowland rice. The area under transplanted rice in world is decreasing due to scarcity of water and labour. So, there is need to search for alternate crop establishment methods to increase the productivity of rice (Farooq *et al*., 2011) [6]. Pandey and Valesco (2005)[15] stated that transplanted rice practiced in areas where low wages for labour and adequate water is available whereas, direct seeded rice can be practiced in areas with high wages and low water availability. Direct seeding of rice reduces labour requirement, shortens the crop duration by 7-10 days and can produce as much grain yield as that of transplanted crop. It needs only 34% of the total labour requirement and saves 29% of the total cost of the transplanted crop (Ho and Romali, 2000) [8]. Direct seeding of rice allows early establishment of the succeeding crop and higher profit in areas with assured water supply by utilizing short duration modern varieties (Balasubramanian and Hill, 2002) [4].

Materials and Methods

The present investigation was undertaken at the Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.) Meerut lies in the heart of Western Uttar Pradesh (latitude of 29^0 40′ North, longitude of 77^0 42′ East and at an altitude of 237 meter above mean sea level) with sub-tropical climate. The experimental field had an even topography with good irrigation and drainage facilities. During crop period (*kharif* 2016) the average maximum weekly temperature ranged between 36.6°C in June to 26.4°C in October, while, average minimum weekly temperature ranged from 11.5°C to 26.4°C. The average weekly maximum relative humidity varied from 96.2 to 72.0 %, while, the lowest 82.6 to 40.0% during June to October. The total amount of rainfall received during crop period was 536.7 mm, out of which about 99.4 % was received during July to September. The experimental soil was sandy loam in texture, low in organic carbon (0.4%) and available nitrogen (221.0 kg/ha), medium in available phosphorus (15.5 kg/ha) and potassium (160.5 kg/ha) with slightly alkaline in reaction. Four crop establishment methods (PTR, UPTR, DSR with wheat straw and DSR without wheat straw mulch), three varieties (Sahbhagi, IR 64 and IR 64 drt 1) and two moisture conservation practices (application of pusa hydrogel @ 1.5 kg/acre and no application) were tested in split-split plot design with 3 replications.

In puddling one deep, two cross ploughing, two wet-tillage operations and one field levelling with a wooden plank was done after ponding the water followed by manually transplanting, done with 25 days old rice seedlings into the puddled field with a spacing of 20 cm×15 cm. The plots are kept flooded for initial one week to establish the seedling and the subsequent irrigation was applied at dried field condition. While, in unpuddled field all the things were same, except puddling. Direct seeded rice with wheat straw mulch required one deep, two cross ploughing and one planking after that seeds were sown with the help of seed drill into the dried field followed by one shallow planking for levelling off the field, application of wheat straw mulch was done after irrigating the field. Direct seeded rice without wheat straw mulch required one deep, two cross ploughing and one planking after that seeds were sown with the help of seed drill into the dried field followed by planking for levelling off the field. Pusa hydrogel was applied in direct seeded rice as fine granules of pusa hydrogel mixed with soil (1:10 w/w) and put it into the seed drill and apply then along with the seeds. Whereas, in transplanted rice the recommended dose of pusa hydrogel (1.5 kg/acre) was mixed with recommended basal fertilizer dose and incorporated them during puddling operation. The crop was grown as per standard recommended package of practices.

The plant height,from randomly selected 5 hills, was measured from the base ofthe plant to the tip of the upper most spikelet and expressed as average plant height in cm.Chlorophyll content was measured through SPAD meter from the randomly selected 5 hills and 2 leaves of each main plant/hill, plot wise while, the relative water content (%) was measured from 50 cm row length/plot and expressed as:

$$\text{RWC (\%)} = \frac{\text{Fresh weight (g)} - \text{Dry weight (g)}}{\text{Turgid weight (g)} - \text{Dry weight (g)}} \times 100$$

The panicle length (cm) was measured from 10 panicles, randomly selected from each net plot and average panicle length was computed by dividing with 10. A handful of seeds were taken without any bias from the total seeds of the plot, afterthreshing and cleaning. One thousand filled grains from each sample was countedand weighed on electronic balance and their weight was expressed in grams to compute the test weight.Net returns were calculated by deducting the cost of cultivation from the respective gross returns (on the basis of prevailing local market price of the inputs and outputs), treatment wise in $Rsha^{-1}$.Dry matter accumulation was recorded by cutting the produce from50 cm row length, randomly selected from observation row in each plot. Selected hills were cut carefully close to the ground surface.

After sun drying these samples were collected in paper bags by cutting in small pieces and were put into an electric oven at 65±2 ^{0}C, till constant weight. After that the weight was recorded on electronic balance and expressed as dry matter accumulation in g m^{-2}.

Benefit cost ratio was calculated by using the following formula:

$$\text{B: C ratio} = \frac{\text{Gross return (Rs ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs ha}^{-1}\text{)}}$$

The organic carbon content in soil was determined by modified Walkley and Black (1934) method (Jackson 1973).Uptake of individual nutrients i.e. N, P and K was worked out by multiplying the straw yield and grain yield with their respective nutrient content (%) as follows:

Nutrient uptake (kg ha^{-1}) = Nutrient content (%) in grains or straw × grains or straw yield (qha^{-1})

Total uptake (kgha^{-1}) = Nutrient uptake from grains (kg/ha) + nutrient uptake from straw (kgha^{-1})

Results and Discussion

Chlorophyll and relative water content

Results of Table 1 revealed that the maximum chlorophyll content and relative water content (%) was recorded in puddled transplanted rice whereas, chlorophyll content in PTR was significantly *at par* to UPTR however, the minimum chlorophyll content and relative water content was recorded in DSR without wheat straw followed by DSR with wheat straw. Among the varieties, IR 64 showed significantly more chlorophyll content and relative water content than Sahbhagi and IR 64 drt 1, which also differed significantly to each other, though the lowest chlorophyll content and relative water content per cent was recorded in IR 64 drt 1. Application of pusa hydrogel @ 1.5 kg acre^{-1} significantly increased the chlorophyll content and relative water content over no application. The highest food materials get synthesized and accumulated during the photosynthesis in plants, more availability of nutrients, crop growth rate and cells enlargement in PTR were responsible for vegetative growth of crop plants which in turn enhanced the chlorophyll content in rice (Manivannan *et al.*, 2007) [13]. The relative water content (RWC) is considered as the best integrated measurement of plant water status, and it represents the variations in water potential, turgor potential and the osmotic adjustment (OA) of the plants. Though, the relative water content varied due to difference in osmotic adjustment (Ameregowda *et al.*, 1994) [1].

Plant height

Among the crop establishment methods plant height increased with advancement in crop age, irrespective of the treatments, and reached to maximum at harvest. The establishment methods, varieties and moisture conservation practices in rice brought significant variation in plant height. At the time of harvesting significantly tallest plants (101.8 cm) were recorded in PTR followed by DSR with wheat straw mulch (94.7 cm), though the shortest plants were recorded under DSR without straw mulch. Among the varieties, Sahbhagi exhibited significantly more plant height the next in the order was IR 64 Drt1 and IR 64. Application of pusa hydrogel @ 1.5 kg acre^{-1} in rice produced 4.1 per cent more plant height at the time of harvesting over no application.

Dry matter production (g m^{-2})

Among the different crop establishment methods, significantly maximum dry matter m^{-2} was recorded in DSR with wheat straw followed by DSR without wheat straw mulch at all the stages of crop growth. At harvest, DSR with wheat straw produced 3.8% more rice dry matterm^{-2}than DSR without wheat straw. However, the minimum dry matter production at harvest (882.4 gm^{-2}) was recorded in UPTR. The next in order was puddled transplanted rice which produces 1024.0 g/m^{2} dry matter at harvest. Naklang*et al*. (1996) [14] and Sharma *et al.* (1999) [18] also reported more dry matter production in direct seeded rice as compared to transplanted rice. Among the varieties, IR 64 had significantly maximum dry matter m^{-2} followed by Sahbhagi. At harvest, IR 64 accumulated 8 and 15% extra dry matter than Sahbhagi and IR 64 drt 1, respectively. However, the minimum dry matter production (969.8 gm^{-2}at harvest) was recorded in IR 64 drt 1.Application of pusa hydrogel @ 1.5 kg acre^{-1} significantly increased the dry matter production over no application. At harvest, 6% more dry matter production was recorded with the application of pusa hydrogel over no application. Our results are in close conformity with those of Yezdani *et al*. (2007) [23].

Yield attributes and yield

Among the crop establishment methods, highest number of effective tillers m^{-2}(277.0) were recorded in DSR with wheat straw which was significantly *at par* to DSR without wheat straw mulch (222.2). While, the lowest number of effective tillersm^{-2} was recorded in UPTR (171.0) followed by puddled transplanted rice (181.0). However, the variety IR 64 exhibited maximum number of effective tillersm^{-2} (207.3) followed by Sahbhagi (197.4) and IR 64 drt 1(196.0) though, Sahbhagi and IR 64 drt 1 were *on par* with each other in this regard. The application of pusa hydrogel @ 1.5 kg acre^{-1} resulted into significantly more number of effective tillersm^{-2} (201.0) over no application.

Panicle length (cm) was significantly affected by the crop establishment methods and varied from 22.2 to 26.1 cm. The maximum panicle length was recorded in puddled transplanted rice followed by UPTR, which were significantly *on par* to each other but statistically superior to rest of the crop establishment methods. Among the varieties, maximum panicle length was recorded in IR 64 drt 1 (25.2 cm) the next in the order were Sahbhagi (24.2 cm) and IR 64 drt 1 (23.1 cm) which were *on par* with each other. The application of pusa hydrogel @ 1.5 kg acre^{-1} resulted into significantly longer panicle length (24.6 cm) than no application. The crop establishment methods, varieties and moisture conservation practices showednon-significant difference in 1000 grains weight of rice. The maximum test weight was recorded in the DSR with wheat straw (22.55 g) followed by the DSR without wheat straw (22.22 g), PTR (22.05 g) and UPTR (21.44 g).However, the variety, IR 64 (22.41 g) had maximum test weight followed by Sahbhagi/IR 64 drt 1 (22.37 g). With the application of pusa hydrogel @ 1.5 kg acre^{-1} rice recorded more 1000 grains weight over no application.

Among the crop establishment methods, the number of filled grains panicle^{-1} varied from 70.0 to 113.2. Significantly maximum number of filled grainspanicle^{-1}was recorded in puddled transplanted rice (PTR) followed by the unpuddled transplanted rice (UPTR). While, the lowest number of filled grains panicle^{-1} was recorded in DSR without wheat straw being *on par* to DSR with wheat straw. Among the varieties, maximum number of filled grainspanicle^{-1}was recorded in IR 64 (93.2) which was significantly *at par* to Sahbhagi. Whereas, the lowest number of filled grainspanicle^{-1}was recorded in IR 64 drt 1. Application of pusa hydrogel @ 1.5 kg acre^{-1} resulted into more number of filled grainspanicle^{-1}(90.5) than no application. However, the difference was not statistically significant. The crop establishment methods, varieties and moisture conservation practices had significant difference in grain yield ha^{-1}. The maximum grain yield was recorded in puddled transplanted rice (4.52 t ha^{-1}) followed by DSR with wheat straw (4.00 tha^{-1}), unpuddled transplanted rice (3.76 tha^{-1}) and DSR without straw (3.44 t ha^{-1}). Although, UPTR and DSR without straw mulch were statistically alike. The puddled transplanted rice out-yielded DSR with wheat straw and DSR without straw by 5.2 and 10.8 qha^{-1}, respectively. The PTR rice exhibited 13% more grains yield as compared to DSR with wheat straw However, among the varieties, IR 64 exhibited maximum grain yield (4.26 tha^{-1}) followed by Sahbhagi (3.94 tha^{-1} and IR 64 drt 1 (3.59 tha^{-1}), besides 8.0 and 18.6% more grains yieldha^{-1} than Sahbhagi and IR 64 drt 1. The application of pusa hydrogel @ 1.5 kg acre^{-1} resulted into statistically and 3.4 % more grain yield over no application. Sridevi *et al.* (2008) [21] also reported the similar results.

The lower number of effective tillers in transplanted rice as compared to DSR might be due to more secondary and tertiary tillers produces in later stages which did not get the sufficient time for optimum development. Singh *et al.* (2005) [20] and Kumar *et al*. (2012) [10] also reported the more number of effective tillersm^{-2} in direct seeded rice as compared to transplanted rice. Application of pusa hydrogel significantly increases the number of effective tillersm^{-2}as compared to no pusa hydrogel, however the filled grains panicle^{-1} had non-significant difference. This increment was mainly because of the efficient conservation of soil moisture which intern increased the moisture supply for better growth in terms of dry matter accumulation due to pusa hydrogel application in rice fields. The poor yields without application of pusa hydrogel might be due to the fact that moisture stress at grain filling stage results in closer of stomata to reduce the water loss which at the same time interferes with the carbon dioxide diffusion thus reducing the photosynthetic efficiency in rice (C_3 plants) and also cause dehydration of protoplasm resulting in reduced photosynthetic rate.

Protein content (%)

Among the crop establishment methods, PTR grains contained significantly maximum protein content (8.1%) followed by DSR with wheat straw and UPTR while, DSR without wheat straw remained *on par* to UPTR showed the lowest protein content (6.4%) in grains. Among the varieties, IR 64 being on par to Sahbhagi accumulated significantly higher protein content (7.4%) than IR 64 drt 1 which had the lowest protein in grains. Application of pusa hydrogel @ 1.5 kg acre^{-1} recorded significantly higher protein content per cent in grains (7.2%) over no application.

Net returns (Rs ha^{-1})

The highest net returns (49,359 Rs ha^{-1}) was recorded under puddled transplanted rice whereas, the lowest (35,459 Rs ha^{-1}) was recorded under DSR without wheat straw. The highest net return in PTR was mainly due to the fact that more economic (grain) yield of rice was produced under this treatment. The variety IR 64 exhibited maximum net returns mainly due to the maximum economic yield produced by this variety, while cost of cultivation remains same in all the verities. Kumar (2015) [10] also made the similar observations, earlier.The lower net return and B: C ratio with the application of pusa hydrogel was because of its higher (Rs 4200ha^{-1}) cost over no application.

Benefit: cost ratio

Among the crop establishment methods, the benefit: cost ratio varied from 1.88 to 2.19. The puddled transplanted rice recorded maximum benefit: cost ratio followed by DSR with wheat straw (2.16), DSR without wheat straw mulch and unpuddled transplanted rice however, puddled transplanted rice, direct seeded rice with wheat straw and unpuddled transplanted rice remained *on par* with each other. The variety, IR 64 resulted into significantly highest benefit: cost ratio (2.21) followed by Sahbhagi (2.05) and IR 64 drt 1(1.87). Kumar (2015) [11] also reported the similar results. Application of pusa hydrogel @ 1.5 kgacre^{-1} statistically registered the lowest benefit: cost ratio over no application.

Total nutrient uptake (kg/ha)

Among the crop establishment methods, PTR recorded significantly maximum total uptake of nitrogen followed by DSR with wheat straw, DSR without wheat straw mulch and UPTR while, UPTR was *on par* to DSR without wheat straw mulch. However, the varieties and moisture conservation practices also showed significant difference in total uptake of nitrogen. While, among the varieties IR 64 accumulated maximum uptake of total nitrogen followed by Sahbhagi and IR 64 drt1. Application of pusa hydrogel @ 1.5 kg acre^{-1} also recorded significantly more total nitrogen (8 %) uptake over no application.

The crop establishment methods, varieties and moisture conservation practices were recorded significant difference in uptake of phosphorus. However PTR was recorded maximum uptake of phosphorus (15.0 kg ha^{-1}) followed by DSR with wheat straw (14.0 kgha^{-1}), UPTR (12.3 kgha^{-1}) and DSR without wheat straw (11.5 kgha^{-1}) while, DSR without wheat straw *at par* to UPTR. The variety, IR 64 was recorded maximum uptake followed by Sahbhagi and IR 64 drt 1. Application of pusa hydrogel @ 1.5 kg acre^{-1} resulted more uptake of phosphorus over no application.

Among the cop establishment methods, the total uptake of potassium varied from 82.0 to 105.2 kgha^{-1}. However, significantly more uptake of potassium was recorded in DSR with wheat straw followed by DSR without wheat straw and PTR. However among the varieties, IR 64 (107.6 kgha^{-1}) exhibited significantly more uptake followed by Sahbhagi (95.2 kgha^{-1}) and IR 64 drt 1 (85.0 kgha^{-1}). Application of pusa hydrogel @ 1.5 kg acre^{-1} in rice accumulated 5.0 % more potassium over no application. More economic yield production under PTR and relatively higher nutrient content in grains are responsible for increasing the total uptake of nitrogen and phosphorus under puddled transplanted rice conditions. Gardner *et al*. (1985) [7] also reported the higher NPK uptake in transplanted rice.

Soil moisture content (%)

Among the crop establishment methods, soil moisture content (%) varied from 7.46 to 9.05% the maximum soil moisture content was recorded in DSR with wheat straw (9.05%) followed by DSR without wheat straw (8.88%), PTR (8.33%) and UPTR (7.46%) though, the soil moisture content in DSR without wheat straw was *on par* to DSR with wheat straw.However, the varieties had failed to moisture conservationin soil. The variety, Sahbhagi exhibited maximum soil moisture content (8.72%) followed by IR 64 (8.41%) and IR 64 drt 1 (8.16%). Application of pusa hydrogel @ 1.5 kg acre^{-1} showed significantly more soil moisture content after harvest of rice over no application. The maximum soil moisture content was recorded under DSR with wheat straw mainly because the wheat straw act as mulch that trap the sun light and act as insulator, reducing the evaporation and thus increasing the available moisture content under this treatment. Application pusa hydrogel also increases the moisture content in soil due to its native characteristics asit conserve the moisture content in soil for longer period of time. Akhter *et al.* (2004) [3] and Yangyuoru *et al.* (2006) [24] also corroborate our results.

Organic carbon content (%)

Among the crop establishment methods, the organic carbon content in soil after harvest of rice varied from 0.37 to 0.48%. Significantly more per cent organic carbon was recorded in DSR with wheat straw than UPTR, whereas the lowest organic carbon was recorded in PTR which was *on par* with DSR without wheat straw mulch. The varieties failed to register any significant difference in soil organic carbon, although Sahbhagi recoded the maximum organic carbon (%). Application of pusa hydrogel @ 1.5 kg acre^{-1} recoded significantly more organic carbon (0.42%) over no application. Campbell *et al*. (1988) [5] and Rath (1999) [17] also reported the similar results.

Table 1: Chlorophyll content (SPAD value), relative water content (%), plant height (cm) and drymatter production (g/m^2) of drought tolerant rice varieties as influenced by various treatments

Treatment	at 60 DAT		at harvest	
	Chlorophyll content (SPAD)	Relative water content (%)	Plant height (cm)	Dry matter production (g/m^2)
Crop establishment methods				
PTR	40.5	80.4	101.8	1024.0
UPTR	39.2	74.7	94.1	882.4
DSR with straw mulch	38.6	75.3	94.7	1146.6
DSR without straw mulch	37.8	73.5	93.5	1104.2
SEm±	0.4	0.7	0.4	5.7
CD (P =0.05)	1.5	2.5	1.5	19.8
Varieties				
Sahbhagi	39.6	77.7	100.0	1032.7
IR 64	39.7	78.1	94.4	1115.4
IR64 drt 1	37.7	72.1	94.6	969.8
SEm±	0.4	0.5	0.3	5.5
CD (P =0.05)	1.2	1.7	0.9	16.6
Moisture conservation techniques				
No application of pusa hydrogel	38.2	75.4	98.3	1068.8
Pusa hydrogel @ 1.5 kg/acre	40.0	76.5	94.4	1009.8
SEm±	0.3	0.3	0.2	3.2
CD (P =0.05)	1.0	1.0	0.6	9.2

Table 2: Yield attributes viz., effective tillers/m^2, panicle length (cm), filled grains/panicle andtest weight (g) and grain yield of drought tolerant rice varieties as influenced by various treatments

Treatment	Effective tillers/m^2	Panicle length (cm)	Filled grains/panicle	Test weight (g)	Grain yield (t/ha)	Protein content (%)
Crop establishment methods						
PTR	181.0	26.1	113.2	22.05	4.52	8.1
UPTR	171.0	24.7	98.0	21.44	3.76	6.5
DSR with straw mulch	227.0	23.6	78.3	22.55	4.00	7.3
DSR without straw mulch	222.0	22.2	70.0	22.22	3.44	6.4
SEm±	3.5	0.5	3.1	0.23	0.10	0.1
CD (P =0.05)	12.1	2.0	11.0	NS	0.30	0.3
Varieties						
Sahbhagi	197.4	24.2	91.6	22.37	3.94	7.3
IR 64	207.3	25.2	93.2	22.41	4.26	7.4
IR64 drt 1	196.0	23.1	84.7	22.37	3.59	6.7
SEm±	1.7	0.4	2.0	0.30	0.03	0.1
CD (P =0.05)	5.1	1.2	6.0	NS	0.10	0.2
Moisture conservation techniques						
No application of pusa hydrogel	199.4	24.6	89.3	22.47	3.87	7.2
Pusa hydrogel @ 1.5 kg/acre	201.0	23.8	90.5	22.30	4.00	6.9
SEm±	0.5	0.2	0.70	0.21	0.01	0.1
CD (P =0.05)	1.4	0.7	NS	NS	0.02	0.2

Table 3: Net returns, B: C ratio, organic carbon (%) in soil and nutrient uptake (kg/ha) by drought tolerant rice varieties as influenced by various treatments

Treatment	Net returns (Rs/ha)	B:C ratio	Nutrient uptake (kg/ha)			Soil Moisture content (%)	Organic carbon (%)
			N	P_2O_5	K_2O		
Crop establishment methods							
PTR	49,359	2.19	92.0	15.0	97.3	8.33	0.36
UPTR	35,550	1.88	65.0	12.3	82.0	7.46	0.40
DSR with straw mulch	44,447	2.16	83.1	14.0	105.2	9.05	0.48
DSR without straw mulch	35,459	1.95	68.0	11.5	99.1	8.88	0.37
SEm±	1,560	0.03	1.1	0.3	1.0	0.15	0.02
CD (P =0.05)	5,386	0.13	4.0	1.0	3.5	0.54	0.08
Varieties							
Sahbhagi	41,455	2.05	78.0	13.0	95.2	8.72	0.42
IR 64	47,973	2.22	87.0	15.0	107.6	8.41	0.39
IR64 drt 1	34,183	1.87	66.0	11.4	85.0	8.16	0.39
SEm±	594	0.01	0.7	0.1	1.2	0.20	0.02
CD (P =0.05)	1,783	0.04	2.1	0.3	3.6	NS	NS
Moisture conservation techniques							
No application of pusa hydrogel	42,010	2.0	80.0	13.5	98.2	9.28	0.42
Pusa hydrogel @ 1.5 kg/acre	40,397	2.1	74.0	12.8	93.5	7.58	0.38
SEm±	226	0.01	0.5	0.1	1.0	0.13	0.01
CD (P =0.05)	660	0.02	1.4	0.2	2.6	0.40	0.03

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