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Effect of Laser Land Levelling and Establishment Methods on Growth and yield of Rice

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ABSTRACT: A field experiment was conducted during the Rabi season, 2020-2021 at Regional Agricultural Research Station, Jagtial to identify better establishment method of rice under different land leveling practices. The experiment was laid out in a strip plot design with three land levelling methods as main plot treatments *viz.*, laser land levelling, conventional land levelling and Control (Unlevelled) and four sub-plots *viz.*, semi dry rice, wet direct seeding, conventional transplanting of rice and machine transplanting. The experimental results revealed that, laser land leveling recorded significantly higher plant height (78.8 cm), tillers m^{-2} (320), dry matter production (1127 g m^{-2}) and yield attributes effective tillers m^{-2} (311), filled grains panicle^{-1} (100), test weight (22.7 g), grain yield (4697 kg ha^{-1}) and straw yield (3628 kg ha^{-1}) compared to conventional land leveling and unleveled control. Among establishment methods significantly higher plant height (85.7 cm), tillers m^{-2} (414), dry matter production (1311 g m^{-2}) and yield attributes effective tillers m^{-2} (401), grain yield (5761 kg ha^{-1}) and straw yield (4436 kg ha^{-1}) recorded with conventional transplanting compared to machine transplanting, wet direct seeding and semi dry rice.

Keywords: Laser land levelling, Methods of establishment, Transplanting, Direct seeding.

INTRODUCTION

Rice is one of the world's most important food crop and a primary source of food for more than half of the world population growing in at least 117 countries under diverse condition. Therefore, rice plays an important role in ensuring food security, poverty, and malnutrition alleviation in the world. The global area under rice cultivation is 1.62 billion hectares with a production of 503.17 m per annum. In India, it is grown in about 43.66 million hectares with a production of 118.8 m and productivity of 2722 kg ha^{-1}. While, in Telangana State, it is grown in an area of 20.11 lakh hectares with a production of 74.27 mt and productivity of 3694 kg ha^{-1} (Indiastat, 2020).

To safeguard and sustain the food security in India, it is quite important to increase the productivity of rice under limited water resources. It is estimated that India will need to produce at least 37 percent more quantity of rice by 2025, with nearly 10 percent less water available for irrigation (Jat *et al.,* 2006). Further, approximately 10-25% of irrigation water is lost during application because of poor water management and uneven fields (Kahlown *et al.,* 2000).

Land levelling is a common agricultural practice which is carried out to improve the irrigation water distribution and soil conservation. Traditional methods of land levelling are cumbersome, time consuming, expensive and do not achieve a high level of smoothness of land surface. However, Laser levelling is a process of smoothing the land surface (± 2 cm) from its average elevation using laser-equipped drag buckets (Jat *et al*., 2006), reduces the work involved with crop establishment and crop management. It increases yield, improves uniformity of crop maturity and reduces weeds and the amount of water needed for land preparation. Laser land levelling saves 15-30 % of water under various crops and cropping patterns (Eid *et al*., 2014). It results in 3 to 4% additional land recovery and improves operational efficiency i.e., reducing operating time by 10-15% leads to reduced consumption of seeds, fertilizers, chemicals and fuel.

Changing climatic condition and depletion of ground water table resulted in scarcity of irrigation water (Mahajan *et al*., 2012). It threatens the sustainability of rice production in irrigated environments (Chauhan *et al*., 2014). Shortage of farm laborer's during the peak season of rice transplanting in many rice growing regions is another major constrain which is aggravating the problem for rice production in irrigated environment (Mahajan *et al*., 2013). Hence, shortage of farm laborer's triggers the search for alternative rice crop establishment methods other than conventional transplanting.

Traditional way of rice transplanting is labour intensive and involves drudgery. Machine transplanting of rice is cost effective and operation friendly. It saves labour to the tune of 90 percent of that required in manual transplanting, minimizes stress and drudgery, ensures timely planting and attains optimum plant density. It helps in maintaining soil physical properties with better crop management and productivity (Guru *et al*., 2018).

Direct seeded rice (DSR) is one of the option available for rice crop establishment having high water productivity and proven to reduce methane emissions due to shorter flooding and decreased soil disturbance compared to transplanting of rice seedlings (Kumar *et al*., 2018). Direct seeding can be done by sowing of pre-germinated seed into a puddled soil (wet seeding) or prepared seedbed (dry seeding). Direct seeding requires about 34% of the total labour cost of transplanted rice without any yield loss (Ho Nai-Kin and Romli, 2002).

MATERIAL AND METHODS

The study was conducted at Regional Agricultural Research Station, Jagtial under Professor Jayashankar Telangana State Agricultural University, Hyderabad during *Rabi*, 2020-21. The composite soil of experimental site is clay loam in texture, low in available nitrogen (195 kg ha^{-1}), high in available phosphorus (46 kg ha^{-1}) and available potassium (354 kg ha^{-1}) with neutral in reaction (pH 7.24) and electrical conductivity 0.24 dsm^{-1}.

Overview of the experimental site.

The experiment was laid out in a strip plot design comprising of three land levelling methods as mainplots *viz*. laser land levelling, conventional and un leveled control and four establishment methods as subplot treatments *viz*. semi dry rice, wet direct seeding, conventional transplanting and machine transplanting replicated thrice.

Land levelling with laser guided leveler.

The experimental site was initially ploughed under dry condition with tractor drawn mould board plough followed by cultivator and rotavator operations to get fine tilth. Later, as per the main plot treatments i.e. laser land levelling , conventional, the land was leveled with laser guided leveler, with jumbo drawn cultivator respectively and no levelling operation performed in control (Unlevelled) plot. Then water was let into the field for puddling with rotovator separately for each main plot treatment with sub plots of wet direct seeding, conventional transplanting and machine transplanting and field was remain un puddled for semi dry rice. Later the field was laid into plots providing with irrigation channels. All recommended package of practices done pertaining to other management practices.

RESULTS AND DISCUSSION

Plant height (cm): Higher plant height was recorded with laser land levelling at vegetative, maximum tillering, panicle initiation and maturity and was significantly superior to conventional levelling and unleveled filed (Table 1), which inturn recorded the lowest plant height at vegetative, maximum tillering, panicle initiation and at maturity.

Higher plant height under laser land levelling might be due to the precision land levelling helps in uniform distribution of water that facilitates good establishment and growth (Jat *et al.*, 2011).

Table 1: Plant height (cm) of rice influenced by land levelling practices and establishment methods.

Treatments	Vegetative stage	Max tillering	Panicle initiation	Grain filling stage	At Harvest
Land levelling practices (M)					
Laser levelling	30.2	59.2	65.0	77.3	78.8
Conventional leveling	28.6	54.6	62.7	73.3	74.7
Unlevelled	26.6	51.4	59.6	69.0	70.4
S.Em ±	0.3	0.3	0.7	1.0	1.0
CD (P = 0.05)	1.1	1.4	2.7	3.8	3.9
Establishment methods (S)					
Semi dry rice	24.2	45.7	48.8	59.6	60.8
Wet direct seeding	24.9	44.9	49.4	66.2	67.6
Conventional transplanting	32.7	65.5	76.3	84.1	85.7
Machine transplanting	32.0	64.1	75.4	82.8	84.5
S.Em ±	0.4	0.9	0.7	0.9	0.9
CD (P=0.05)	1.5	3.0	2.4	3.1	3.1
Interactions (M x S)					
Factor (B) at same level of A					
S.Em ±	0.6	0.8	1.0	0.8	0.8
CD (P = 0.05)	NS	NS	NS	NS	NS
Factor (A) at same level of B					
S.Em ±	0.6	0.8	1.0	1.2	1.2
CD (P = 0.05)	NS	NS	NS	NS	NS

Among different establishment methods of rice significantly higher plant height was recorded with conventional method of transplanting at vegetative, maximum tillering, panicle initiation and maturity respectively and was comparable with machine transplanting and significantly superior to wet direct seeding and semi dry rice. The higher plant height under transplanted condition might be due to the puddle condition which led to less crop weed competition and produced taller plants. (Rahman *et al.*, 2019). These results were in close agreement with findings of Soriano *et al.,* (2018); Poudel *et al.,* (2021).

Number of tillers m^{-2}: Laser land leveling produced significantly more tillers m^{-2}, at vegetative, maximum tillering, panicle initiation, grain filling and physiological maturity over conventional land leveling and unleveled field (Table 2). More number of tillers under laser land leveling might be due to uniform germination, establishment of rice seedlings and availability of nutrient and soil moisture in the effective root zone of the crop (Naresh *et al.,* 2014).

The highest number of tillers m^{-2} was inscribed in conventional transplanting at maximum tillering, panicle initiation, grain filling and at physiological maturity stages and was significantly superior to machine transplanting, Wet direct seeding and semi dry rice. Higher number of tillers m^{-2} produced under conventional transplanting as the plants were spaced at specific distance and the competition between the plants was minimum for efficient utilization of all the available resources, there by better translocation of photosynthates from source to sink (Nagabhushanam and Bhatt, 2020).

Table 2: Number of tillers m^{-2} of rice as influenced by land levelling practices and establishment methods.

Treatments	Vegetative stage	Max tillering	Panicle initiation	Grain filling stage	At Harvest
Land levelling practices (M)					
Laser levelling	129	361	351	334	320
Conventional leveling	123	329	321	305	295
Unlevelled	120	316	304	289	280
S.Em ±	1.3	5	7	6	4
CD (P = 0.05)	5.4	20	26	24	16
Establishment methods (S)					
Semi dry rice	152	251	243	231	228
Wet direct seeding	156	295	287	272	261
Conventional transplanting	103	468	454	431	414
Machine transplanting	85	327	317	302	290
S.Em ±	3.4	4.7	4.7	4.5	4.4
CD (P = 0.05)	11.7	13.7	16.5	15.7	15.2
Interactions (M x S)					
Factor (B) at same level of A					
S.Em ±	5.6	8.5	7.0	6.6	8.6
CD(P = 0.05)	NS	NS	NS	NS	NS
Factor (A) at same level of B					
S.Em ±	5	9.0	8.9	8.4	8.5
CD (P = 0.05)	NS	NS	NS	NS	NS

Dry matter production (g m^{-2}): Significantly the highest dry matter was produced from laser land leveling at maximum tillering, panicle initiation, grain filling and at maturity over conventional land leveling and unlevelled filed (Table 3).

Table 3: Dry matter production (g m^{-2}) of rice as influenced by land levelling practices and establishment methods.

Treatments	Vegetative stage	Max tillering	Panicle initiation	Grain filling stage	At Harvest
Land levelling practices (M)					
Laser levelling	13.1	260	519	950	1127
Conventional levelling	10.4	218	436	782	1000
Un levelled	9.9	203	390	708	934
S.Em ±	0.9	9	18	26	19
CD (P = 0.05)	NS	34	71	104	76
Establishment methods (S)					
Semi dry rice	11.5	168	304	620	855
Wet direct seeding	12.1	202	371	711	921
Conventional transplanting	13.2	296	683	1073	1311
Machine transplanting	7.8	243	435	851	995
S.Em ±	0.7	9	18	29	18
CD(P = 0.05)	2.6	31	55	87	63
Interactions (M x S)					
Factor (B) at same level of A					
S.Em ±	1.6	21	22	43	31
CD(P = 0.05)	NS	NS	NS	NS	NS
Factor (A) at same level of B					
S.Em ±	1.6	20	26	46	33
CD (P = 0.05)	NS	NS	NS	NS	NS

Accumulation of higher dry matter was observed with conventional transplanting at vegetative, maximum tillering, panicle initiation, grain filling and physiological maturity stages and it was significantly superior to machine transplanting, wet direct seeding and semi dry rice. Maximum increment in dry matter accumulation in transplanted method might be due to increased amount of photosynthate accumulation, nutrient availability and soil moisture than closely spaced rice plants under semi dry and semi wet establishment methods. Though machine transplanting produced higher dry matter production per plant but due to less number of hill per unit area the amount of dry matter production per unit area is less compared to conventional transplanting. The results are in line with the findings of Thapliyal *et al.* (2020).

Number of effective tillers m^{-2}: Maximum number of effective tillers m^{-2} was observed with laser land leveling and was significantly superior to conventional land levelling and unleveled filed. Methods of establishment showed remarkable effect on number of effective tillers m^{-2}. Higher number of effective tillers m^{-2} were produced from conventional transplanting and was significantly superior to machine transplanting, Wet direct seeding and semi dry rice, which inturn, recorded lowest number of effective tillers m^{-2} (Table 4).

The higher number of effective tillers m^{-2} in transplanted rice might be due to optimum plant population, plant geometry coupled with transplanting young seedlings that resulted in even distribution of available resources viz., sun light, moisture, nutrients among rice plants leading to better growth, yield attributes. These results are in corroborate with the findings of Pasha *et al*., (2009); Ramulu *et al*., (2019); Nagabhushanam and Bhatt (2020).

Number of spikelets panicle^{-1}: Significantly the highest number of spikelets panicle^{-1} was observed from laser land leveling and was significantly superior to conventional levelling and unleveled field. Machine recorded higher number of spikelets panicle^{-1} and was significantly superior to conventional, wet direct seeding and the lowest was recorded with semi dry rice (Table 4).

Number of filled grains panicle^{-1}: Significantly highest number of filled grains panicle^{-1} was recorded in laser land levelling followed by the conventional land levelling and the lowest was recorded with unlevelled treatment. Among establishment methods machine transplanting recorded more number of filled grains panicle^{-1} and was significantly superior to conventional transplanting, Wet direct seeding and semi dry rice, which in turn, recorded the lowest number of filled grains panicle^{-1} (Table 4).

Test weight (g): Significantly higher test weight (g) was noticed with laser land levelling over conventional land levelling and unlevelled treatment which in turn, recorded the lowest test weight. Uniform distribution of moisture and nutrient in uniformly sloppy leveled fields, fields might have led better crop establishment resulted in higher test weight under laser leveled filed. The results are inconformity with the findings of Das *et al.,* (2018). Establishment methods didn't showed significant influence on test weight (g) of rice (Table 4).

Table 4: Yield attributes of rice as influenced by land levelling practices and establishment methods.

Treatments	Number of effective tillers m^{-2}	Number of Spikelets panicle^{-1}	Number of filled grains panicle^{-1}	Panicle length (cm)	Test weight (g)
Land levelling practices (M)					
Laser levelling	311	114.5	100.2	19.9	22.7
Conventional levelling	286	99.3	86.7	19.6	22.5
Un levelled	271	87.9	76.1	19.3	22.1
S.Em ±	4.0	3.1	3.4	0.9	0.0
CD(P=0.05)	14	12.0	13.4	NS	0.2
Establishment methods (S)					
Semi dry rice	223	71.2	62.5	18.4	21.9
Wet direct seeding	252	86.4	77.5	19.4	22.4
Conventional transplanting	401	109.5	95.6	19.0	22.6
Machine transplanting	281	135.0	115.0	21.6	22.7
S.Em ±	4.0	1.9	2.0	1.0	0.2
CD (P = 0.05)	12	6.7	6.5	NS	NS
Interactions (M x S)					
Factor (B) at same level of A					
S.Em ±	7.0	3.7	3.4	1.8	0.1
CD (P=0.05)	NS	NS	NS	NS	NS
Factor (A) at same level of B					
S.Em ±	7.0	4.4	4.5	1.8	0.1
CD(P = 0.05)	NS	NS	NS	NS	NS

Grain yield (kg ha^{-1}): The percent increase in grain yield with laser land leveling over conventional land levelling and unleveled field was 18.3% and 24.2% respectively. Level field plays an important role in even distribution of soil moisture throughout the crop period that enhances the uniform establishment, crop growth and ultimately the yield (Ashraf *et al*., 2017). The results were in conformity with the findings of Aryal *et al.* (2015).

Among establishment methods significantly higher grain yield was recorded with conventional transplanting followed by machine transplanting and wet direct seeding. While, significantly lowest grain yield was recorded with semi dry rice (Table 5).

The percent increase in grain yield with conventional transplanting over semi dry rice, wet direct seeding and machine transplanting was 133%, 76% and 13% respectively.

Reduction in yield under semi dry rice might be due to reducing availability of soil nutrients such as nitrogen, iron, and zinc, plus more soil carbon loss due to frequent wetting and drying (Kumar and Ladha, 2011). Further, less grain yield under direct seeded rice could have been due to the exposure of seeds to pest destruction and higher weed infestation (Kumar *et al.*, 2018 b).

Straw yield (kg ha^{-1}): Significantly higher straw yield was recorded with laser land levelling followed by conventional land levelling. While, lower straw yield was recorded with unlevelled treatment. The percent increase in straw yield with laser land leveling (M_1) over conventional land levelling and unleveled field was 14.9% and 18.3% respectively.

Among establishment methods significantly higher grain yield was recorded with conventional transplanting followed by machine transplanting and wet direct seeding. While, significantly lowest grain yield was recorded with semi dry rice (Table 5). The percent increase in straw yield with conventional transplanting over semi dry rice, wet direct seeding and machine transplanting was 129%, 67% and 7% respectively.

Puddle transplanting method of establishment recorded significantly higher straw yield compared to direct sowing of rice due to less crop weed competition in transplanting method which led to taller plants, more number of tillers and dry matter production which in turn resulted in higher straw yield (Parameswari and Srinivas, 2014). Similar results were also reported by Subramanyam *et al*., (2007); Bharadwaj *et al.*, (2016).

Harvest index (%): Harvest index shows the physiological efficiency of plants to convert the fraction of photo assimilates to grain yield. Variation in harvest index was observed with different land leveling practices. The maximum harvest index was observed with laser land levelling and was comparable with conventional land leveling inturn, significantly superior to recorded unleveled field. Establishment methods didn't showed any significant influence on harvest index of rice (Table 5).

Table 5: Grain yield, straw yield and harvest index of rice as influenced by land levelling and establishment methods.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index
Land levelling practices (M)			
Laser levelling	4697	3628	0.56
Conventional leveling	3968	3157	0.56
Un levelled	3780	3066	0.55
S.Em ±	102	76	0.001
CD (P = 0.05)	400	300	0.005
Establishment methods (S)			
Semi dry rice	2470	1936	0.56
Wet direct seeding	3265	2652	0.55
Conventional transplanting	5761	4436	0.56
Machine transplanting	5097	4112	0.55
S.Em ±	78	75	0.005
CD (P = 0.05)	190	259	NS
Interactions (M x S)			
Factor (B) at same level of A			
S.Em ±	152	103	0.006
CD(P = 0.05)	NS	NS	NS
Factor (A) at same level of B			
S.Em ±	167	118	0.005
CD (P = 0.05)	NS	NS	NS

CONCLUSION

Cultivation of rice under laser leveled filed with conventional transplanting found to be better for increasing the growth and yield of rice.

FUTURE SCOPE

Effect of laser land leveling on performance of different crops and profitability can be studied at farmer's field condition in different crops.

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Conflict of Interest. None.

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