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Studies on Different Methods of Sowing for Blackgram (*Vigna mungo* L.) under Rice Fallows

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ABSTRACT

Five methods of sowing for blackgram under rice fallows *viz*., T1- Broadcasting before 7 days of harvesting (farmers practice); T2- Conventional seed drill + Rotary slasher (no tillage); T3- Stubble manager cum crop planter (strip tillage cum mulching); T4- Cultivator + Rotavator + Conventional seed drill (Conventional tillage) and T5- Broadcasting after harvesting + Rotavator (reduced tillage) were studied at Agricultural College Farm, Bapatla during *rabi* 2021-22. Soil moisture content in three depths of soil *viz*., 0-10, 10-20 and 20-30 cm, soil temperature in 0-5 cm depth, crop growth and yield parameters and economics were studied. Average soil moisture content in T3 was the highest compared to T1, T2, and T5 and the lowest average soil moisture content was recorded in T4 during the entire crop period for all depths of soil. Similar trend was also observed in average soil temperature. No significant difference between average plant population at both 15 and 30 DAS was observed. No significant difference in average plant height at 30 DAS was also noted. Significant difference was found in average plant height at 60 DAS. The highest seed yield of 1090 kg ha^{-1} was obtained in treatment T3 followed by T1 (820 kg ha^{-1}), T2 (804 kg ha^{-1}) and T5 (667 kg ha^{-1}) and the lowest yield was observed in T4 (553 kg ha^{-1}). Similar trend was also observed for haulm yield and harvest index. It was observed that B:C ratio of T1 and T3 was 3.36 and 3.27 and increase in net returns was Rs 12498 for T3 in comparison to T1. Increase in net returns for T3 was Rs 18851 and Rs 25471 compared to T2 and T5 respectively. The lowest B:C ratio was obtained in treatment T4. The highest increase in net income was Rs 39390 for T3 compared to T4.

***Keywords*:** *Blackgram, Mulching, Rice-fallows, Strip-tillage and Sowing*

Rice-fallows are those areas where rice is grown during the *kharif* growing season (June–October), followed by a fallow (a stage of crop rotation whereby the land is deliberately not used to grow a crop) during the *rabi* season (November–February) (Gumma *et al*., 2016). As per revised estimates, approximately 11.7 million ha of land in India is left fallow which accounts for 79% of the total rice fallows of South Asia (15.0 million ha) during *rabi* and summer after the *kharif* rice harvest and this is mostly confined to rainfed rice fallow (Gumma *et al*., 2016). Rice fallows are mainly spread in the states of Andhra Pradesh, Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, West Bengal and Uttar Pradesh (Subbarao *et al*., 2001 and Singh *et al.,* 2016). The coastal region of South Indian States *viz*., Andhra Pradesh, Karnataka and Tamil Nadu form an important rice fallow ecology in India. In Andhra Pradesh, 0.31 million ha is kept as rice fallow which is about 11.5% of *kharif* rice area (2.66 million ha), rice fallows are widely distributed in rainfed ecosystem of districts *viz*., Krishna, Guntur, East Godavari, West Godavari, Srikakulum, Nellore and Prakasam (NAAS, 2013). Rice fallows are suitable for short-season (3-4 months), low water-requiring (thriving best on residual moisture with adequate conservation measures) grain legumes such as chickpea (*Cicer arietinum* L.), blackgram (*Vigna mungo*), greengram (*Vigna radiata*), lentils and lathyrus.

Traditionally farmers sow pulse crop seed by broadcasting method as relay cropping in the standing crop of rice at 7-10 days before its harvest. However, this method may affect germination of seeds due to uneven distribution and improper seed-soil contact. Further, under broadcasting, uneven crop stand results in competition between plants for resources like light, moisture, space, and nutrients in densely grown areas. As a result, there may be reduced crop growth and yield on the other which warrants a suitable intervention. Also, relay cropping of pulse in standing rice crop forces the farmers to go for harvesting by using manual labour instead of combine harvester due to trampling of pulse crop seedlings emerged at the time of harvesting. Thereby, the harvesting cost of paddy crop might be increased much for the farmers. Line sowing is the most efficient method of sowing the crops and most suitable for crop management (Devnani, 1989). A better seed to soil contact is maintained in line sowing method and it could result in better establishment of the crop in the soil. In this context, a study was conducted on local and improved methods of sowing of blackgram under rice fallows.

MATERIAL AND METHODS

Selection of the Treatments and Blackgram Cultivar

The treatments were selected based on the local and improved methods of sowing for pulses under rice fallows. The details of the treatments are given in Table 1. Broadcasting of pulses in standing paddy crop is shown in Fig. 1. The specifications of the farm machinery used *viz*., stubble manager cum crop planter, conventional seed drill, rotary slasher, rotavator and cultivator (Fig. 2 to 6) in all the treatments are given in Table 2 to 6, respectively.

Table 1. Treatments selected for study on different methods of sowing of blackgram under rice fallows

S. No.	Treatment description	Treatment number	Date of sowing	Date of harvesting
1.	Broadcasting before 7 days of harvesting (farmers practice)	T1	10.01.2022	28.03.2022
2.	Conventional seed drill + Rotary slasher (no tillage)	T2	31.01.2022	18.04.2022
3.	Stubble manager cum crop planter (strip tillage cum mulching)	T3	-do-	-do-
4.	Cultivator + Rotavator + Conventional seed drill (Conventional tillage)	T4	-do-	-do-
5.	Broadcasting after harvesting + Rotavator (reduced tillage)	T5	-do-	-do-

The machine used in the treatment T3 *i.e*., stubble manager cum crop planter was designed and developed at Dept. of Farm Machinery and Power Engineering, Dr. NTR College of Agricultural Engineering, Bapatla for sowing of pulses under rice fallows. This machine could do mulching, strip tillage and sowing in a single pass. Mulch created by this machine could be uniformly spread on the surface of field and it prevents evaporation of residual soil moisture from the field. Strip tilling operation incorporates paddy residue in furrow strips of soil and there by sowing could be done easily. Farm machinery used in other treatments were being used in general by the local farmers for sowing of blackgram under rice fallows in addition to broadcasting method. It is often difficult to use conventional seed drill in rice fallow fields as combine harvesting of rice leave the fields with large amounts of loose and anchored crop residues. The paddy straw present in the field was often built up in front of the tines of the drill and eventually blocks the tine and frame, causing unwanted interruptions, uneven seeding rate and depth and a patchy stand of plants (Graham *et al.*, 1986 and Shukla *et al*., 2002). Rotary slasher in Treatment

T2 was used for shredding of paddy stubbles after sowing by conventional seed drill. The shredded stubbles could act as mulch on the surface of field. Blackgram seed of variety LBG 104 was used for sowing in all the treatments. This variety was released by ANGRAU, Lam, Guntur in the year 2016. It is suitable for all seasons and has a medium crop duration 75-80 days. It is resistant to Yellow Mosaic Virus and has yield potential up to 18-20 q ha^{-1}. A sowing gap of three weeks was kept between Treatment T1 and other treatments as to make experimental field suitable for operation of farm machinery by excess moisture evaporation.

Experimental Site, Layout and Statistical Analysis

The experiments were conducted during *rabi* season of the year 2021-22 at Agricultural College Farm, Bapatla, Guntur District, Andhra Pradesh. The soil type of the experimental field was sandy loam. The experiment was laid out in Randomized Block Design (RBD) with five treatments and three replications. The size of each plot was 20 × 6 m. The randomization of treatments was done with the help of random table for each replication. One way factor analysis was conducted for the statistical evaluation of all the treatments. The statistical analysis of the data was done through statistical software SPSS.

Measurement of Soil Parameters

Soil moisture

Soil moisture content was determined gravimetrically in three depths at 0-10, 10-20 and 20-30 cm as per the procedure by Sidhu *et al.* (2007) in experimental plots of treatments on every week at random places with three replications. Comparison was made between treatments to study effect of mulching on evaporation of residual soil moisture content of the experimental field.

Soil temperature

Soil temperature was measured at 5 cm depth daily at 1700 pm hours from the date of sowing to data of harvesting by using digital thermometer as per the procedure by Sidhu *et al.* (2007). Observations of soil temperature were taken at three random places of treatments in the experimental field. Comparison was made between treatments for the study of effect of mulching on evaporation of residual soil moisture content of the experimental field.

Measurement of Crop Growth Parameters

The average plant population was recorded in each plot for all the treatments at 15 and 30 DAS using 1 m × 1 m iron square ring and expressed as number of plants per square meter area. Average plant height was measured from ground level up to the growing tip of the best developed branch at 30 and 60 DAS. After maturity of the crop, blackgram plants were harvested manually in a plot of 1 m × 1 m and then pods were separated from the harvested plant and sundried. Then seeds were separated from the pods manually and seed weight was measured in g m^{-2}. Seed weight per square meter area was converted into kg ha^{-1} to express seed yield. The haulm yield was calculated by subtracting the seed yield from biomass weight of corresponding harvested plant before going for separation of pods from plants and expressed in kg ha^{-1}. Harvest index was calculated from the ratio of seed yield to the total biological yield (seed + haulm) and expressed in per cent.

Economical Comparison between Methods of Sowing

The cost economics for the selected treatments were compared by calculating the cost of cultivation, gross returns, net returns, and benefit-cost ratio (B:C). Gross returns were calculated for all the treatments by considering minimum support price of blackgram (Rs 64 kg^{-1}) and local market price of haulm (Rs 2 kg^{-1}) during the year 2021-22. Cost of operation for all the farm machinery used in the treatments was calculated by straight line method (Sahay, 2019).

RESULTS AND DISCUSSION

Soil Moisture Content

The results of the experiments on weekly soil moisture content in soil depths 0-10, 10-20 and 20-30 cm for all the treatments are illustrated in Fig. 7.

Soil depth 0-10 cm

Average weekly moisture content in the soil depth 0-10 cm was higher in case of T1 compared to other treatments because of rainfall (60.3 mm) which was received during the first week of crop period. It was noticed that, T3 had maximum soil moisture

content (20.04 %) in the last week of crop period compared to other treatments. It may be due to less soil disturbance and better mulch created by the developed machine under T3 reduced soil exposing with air and sun for evaporation of soil moisture. Minimum soil moisture content (9.81 %) was noticed for T4 in the last week of crop period compared to other treatments. Absence of mulch due to complete incorporation of paddy stubbles and loose straw in soil by conventional tillage under T4 increased the evaporation of residual moisture from the soil. Sidhu *et al.* (2007) reported that, there was a consistent trend for higher gravimetric soil water content in the surface soil with mulch compared with no mulch. Hossain *et al.* (2014) showed that, soil moisture was maintained for longer period under strip tillage compared to conventional and minimum tillage. Therefore, from the studies on soil moisture retention in 0-10 cm depth for all the treatments, there was a significant effect of mulch on evaporation of residual soil moisture. The retained residual soil moisture by the mulch in T3 may help for better growth of rice fallow blackgram crop compared to other treatments.

Soil depth 10-20 cm

The average weekly moisture content in the soil depth 10-20 cm was highest for the treatment T1 (19.87 %) followed by T3 (19.76 %), T2 (17.90 %), T5 (15.62 %) and T4 (14.67 %). It was noticed that, T3 had maximum soil moisture content (16.51 %) in the last week of crop period compared to other treatments. Minimum soil moisture content (9.37 %) was noticed for T4 in the last week of crop period compared to other treatments. Sidhu *et al.* (2007) reported that, there was a significant difference in water content up to 30 cm soil layer between mulched and un-mulched treatments. Hence there was a significant effect of mulch on the evaporation of residual soil moisture from the soil depth 10-20 cm.

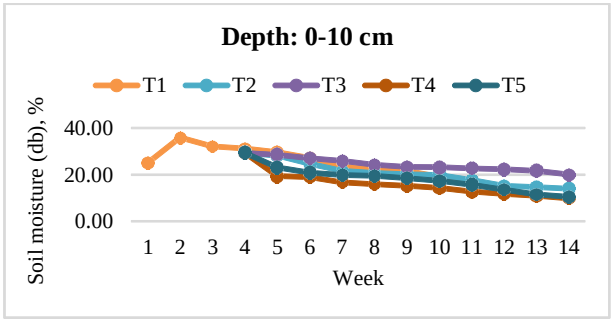
Soil depth 20-30 cm

The average weekly moisture content in the soil depth 20-30 cm was highest for the treatment T3 (17.46 %) followed by T1 (16.90 %), T2 (15.76 %), T5 (14.41 %) and T4 (13.12 %). It was observed that, T3 and T4 had maximum and minimum soil moisture content of 15.16 and 8.72 % in the last week of crop period compared to other treatments.

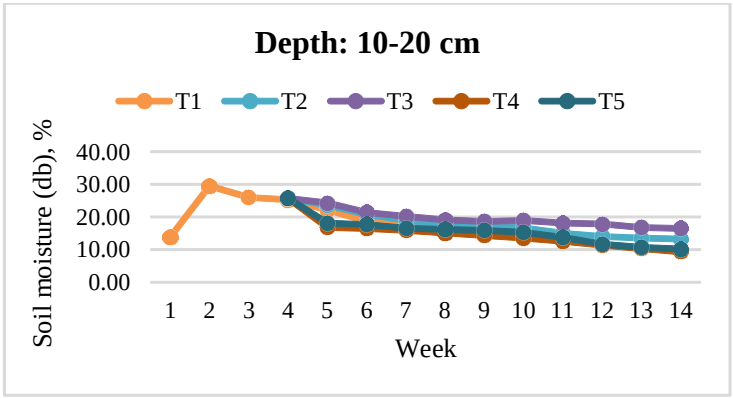
Soil Temperature

The results on variation between the treatments for average weekly soil temperature is shown in Fig. 8.

The average soil temperature was minimum for the treatment T3 (29.7 ^{0}C) followed by T1 (30.0 ^{0}C), T2 (31.1 ^{0}C), T5 (31.4 ^{0}C) and T4 (31.7 ^{0}C) during the entire crop period. The difference in average weekly soil temperature between the treatments T3 and T4 was 2 ^{0}C. Treatments T1, T2, T3 and T5 dropped temperature between soil and ambient by 1.1-2.5 ^{0}C. Whereas treatment T4 dropped temperature between soil and ambient by only 0.5 ^{0}C. These results suggested that, treatments T1, T2, T3 and T5 buffered soil against temperature fluctuations better than T4. This is likely to have positive effect on soil micro-flora, water and nutrient availability and plant growth (Gathala *et al.*, 2011). The soil temperature difference mulched and un-mulched treatments was found as 1-5 ^{0}C (Pannu, 2005 and Sidhu *et al.*, 2007). Therefore, mulch created by the developed machine under T3 reduced soil temperature and helps in better growth of the blackgram crop sown compared to other treatments.



(i)



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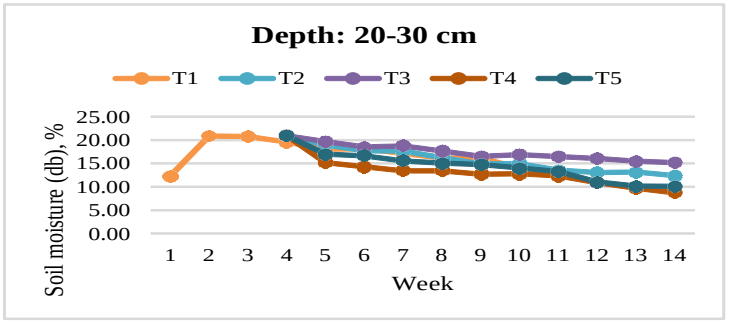

(iii)

Fig. 7 Variation of weekly soil moisture content in all the treatments at 0-10, 10-20 and 20-30 cm depth of soil

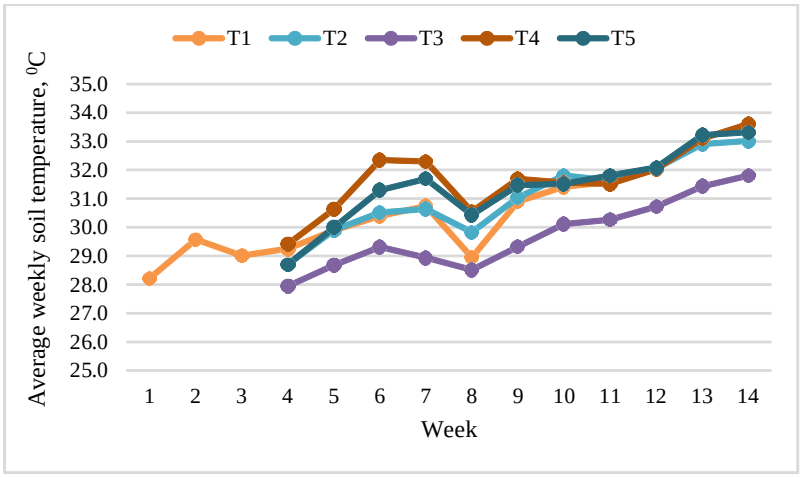

Fig. 8 Variation of weekly average soil temperature at 0-5 cm depth of soil

Plant Population

Plant population was noted at 15 and 30 DAS in the experimental plots of all treatments. The results are presented in the Table 7. It was observed that there was no significant difference between the treatments for average plant population at both 15 and 30 DAS. However, there was higher coefficient of variation (more than 20%) for the treatments T1 and T5 in plant population at both 15 and 30 DAS. Reason for this might be due to manual broadcasting of blackgram seed resulted higher variation in uniformity of spread over the field. Also, the coefficient of variation for the treatment T2 was more than 10% at both 15 and 30 DAS. It might be due to, obstruction of furrow openers in conventional seed drill by paddy stubbles in the field caused variation in uniformity of sowing. Average plant population was varied from 44 to 53 and 41 to 51 at 15 and 30 DAS respectively.

Plant Height

Plant height was noted at 30 and 60 DAS in the experimental plots of all treatments. The results are presented in the Table 7. It was observed that, plant height was not significant at 30 DAS and significant at 60 DAS. Average plant height was varied from 18.1 to 28.6 cm and 26.4 to 34.1 can respectively at 30 and 60 DAS respectively. Higher average plant height of 34.1 cm was observed in T3 at 60 DAS compared to other treatments. It showed that, there was a significant effect of conserved residual soil moisture by the mulch on plant height during pod filling stage of the plants in T3 (Banerjee *et al.*, 2021).

Table 7 Comparison of crop growth parameters between the treatments

Treatment	Mean plant population, number m^{-2}				Mean plant height, cm			
	15 DAS	CV	30 DAS	CV	30 DAS	CV	60 DAS	CV
T1	46	26.71	43	26.70	21.0	12.17	30.8	7.78
T2	46	11.97	44	13.06	20.1	15.15	29.7	8.83
T3	53	3.94	51	4.48	28.6	11.83	34.1	6.84
T4	49	8.78	48	9.66	23.4	14.58	27.6	12.80
T5	44	27.64	41	29.81	18.1	15.26	26.4	10.97
F-value	0.750		1.046		0.547		4.373	
Significance	0.57255 NS		0.41452 NS		0.70703 NS		0.00553*	
CD	N/A		N/A		N/A		2.084	

T1: Broadcasting in standing paddy crop, T2: Conventional seed drill + Rotary slasher, T3: Stubble manager cum crop planer, T4: Broadcasting + Rotavator and T5: Cultivator + Rotavator + Conventional seed drill (Conventional tillage).
* - Significance at 5% level and NS – Non significant.

Seed Yield

Average seed yield was noted in all the treatments and the results are given in Table 8. It was observed that, there was a significant difference in seed yield for all the treatments. Highest seed yield of 1090 kg ha^{-1} was obtained in treatment T3 followed by T1 (820 kg ha^{-1}), T2 (804 kg ha^{-1}) and T5 (667 kg ha^{-1}). Developed machine *i.e.*, stubble manager cum crop planter (T3) could do strip-till sowing cum mulching operation under rice fallows harvested by combine. Conservation agriculture can be achieved through various conservation tillage practices *viz.* zero tillage (zero-till seed drill) or minimum tillage (strip-till seed drill or roto seed drill) both will result in minimal mechanical soil disturbance. Singh *et al.,* (2005) observed that, strip till drilling resulted in higher growth, grain and straw yields followed by zero till drilling, conventional sowing and bed planting under rice-wheat cropping system. Behera *et al.* (2014) found that, grain yield, stover yield, yield attributes and net returns of greengram sown under rice fallow system were significantly improved with one of the conservation agricultural practices (zero tillage and rice residue cover on soil surface) compared to conventional tillage. Amuthaselvi *et al.* (2019) recorded 38.96 % yield increase in demonstration plots sown with zero-till seed drill when compared with conventional broadcasting method under rice fallow conditions. Therefore, there was a significant effect of conserved residual soil moisture by the mulch on seed yield of crop in T3 and highest yield was achieved for this treatment in comparison to other treatments. Lowest seed yield of 553 kg ha^{-1} was recorded in T4 (conventional tillage) as there was no any mulch on the surface of soil for decreasing the evaporation of residual soil moisture.

Haulm Yield

Average seed yield was noted in all the treatments and the results are given in Table 8. It was observed that, there was a significant difference in haulm yield for all the treatments. Highest haulm yield of 2753 kg ha^{-1} was obtained in treatment T3 followed by T2 (2190 kg ha^{-1}), T1 (2080 kg ha^{-1}), T5 (1973 kg ha^{-1}) and lowest haulm yield was recorded in T4 (1577 kg ha^{-1}). Conserved residual soil moisture by the mulch under T3 helped in good growth of crop and achieved highest haulm yield compared to other treatments. As there was no any mulch on the surface of soil for decreasing the evaporation of residual soil moisture, treatment T4 achieved lowest yield.

Harvest Index

Harvest index was calculated from seed and haulm yields of blackgram crop under rice fallows for all the treatments and results are shown in Table 8. It was found that, there was no significant difference for harvest index in between the treatments and it ranged from 26.0 to 28.4 %.

Economical Comparison between Methods of Sowing

Gross returns were calculated for all the treatments by considering cost of cultivation and minimum support price (MSP) of blackgram during the year 2021-22. The results are presented in Table 9. MSP for the blackgram seed was taken as Rs 64 kg^{-1} and local market price for the haulm was taken as Rs 2 kg^{-1}. It was observed that, there was a significant difference in gross returns, net returns, and benefit-cost ratio for all the treatments. It was observed that, T1 achieved highest B:C ratio with 3.36 and followed by T3 with 3.27 with net returns Rs 39769 and Rs 52267 respectively. However, both the B:C ratio values of T1 and T3 were on par with each other and increase in net returns was Rs 12498 for T3 in comparison to T1. Increase in net returns for T3 was Rs 18851 and Rs 25471 compared to T2 and T5 respectively. Lowest B:C ratio of 1.50 was obtained for treatment T4. Highest increase in net income was Rs 39390 for T3 compared to T1. Hossain *et al.*(2014) reported significant increase in net savings for wheat, lentil and greengram crops by strip-tillage compared to conventional tillage. Singh and Singh (2006) found a significant increase in net savings for lentil crop using zero-till seed drill under combine harvested paddy conditions compared to conventional tillage. Therefore, there was a significant effect of conserved residual soil moisture by the mulch on crop yield in T3 compared to other treatments and finally reflected higher net savings for this treatment compared to other treatments.

Table 9 Economical comparison between the treatments for rice fallow pulse crop (blackgram) sowing

Treatment	Cost of sowing (Rs ha^{-1})	Cost of cultivation including sowing (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
T1	750	16850	56619	39769	3.36[a]
T2	6320	22420	55836	33416	2.49[b]
T3	6900	23000	75267	52267	3.27[a]
T4	9590	25690	38567	12877	1.50[c]
T5	3760	19860	46656	26796	2.35[b]
F-value	--	--	27.264	31.166	34.711
Significance	--	--	0.00010*	0.00006*	0.00004*
CD	--	--	8701.601	8701.601	0.427

T1: Broadcasting in standing paddy crop, T2: Conventional seed drill + Rotary slasher, T3: Stubble manager cum crop planer, T4: Broadcasting + Rotavator and T5: Cultivator + Rotavator + Conventional seed drill (Conventional tillage). * - Significance at 5% level and NS – Non significant.

The average weekly moisture content in 0-10 cm depth of soil was highest for the treatment T1 (25.95 %) followed by T3 (24.39 %), T2 (20.57 %), T5 (18.17 %) and T4 (15.91 %). T3 had highest soil moisture content (20.04 %) and T4 had lowest soil moisture (9.81 %) in the last week of crop. For 10-20 cm depth of soil, T3 had highest soil moisture content (16.51 %) and T4 had lowest soil moisture content (9.37 %) in the last week of crop period. For 20-30 cm depth of soil, the average weekly moisture content was highest for the treatment T3 (17.46 %) followed by T1 (16.90 %), T2 (15.76 %), T5 (14.41 %) and T4 (13.12 %). The average soil temperature was minimum for the treatment T3 (29.7 ^{0}C) followed by T1 (30.0 ^{0}C), T2 (31.1 ^{0}C), T5 (31.4 ^{0}C) and T4 (31.7 ^{0}C) during the entire crop period. No significant difference between average plant population at both 15 and 30 DAS was observed. No significant difference in average plant height at 30 DAS was observed. Significant difference was found in average plant height at 60 DAS. Highest average plant height 34.1 cm was observed in T3 at 60 DAS and for T1,

T2, T4 and T5, it was 30.8, 29.7, 27.6 and 26.4 cm respectively. Significant difference in seed and haulm yields was observed. Highest seed yield of 1090 kg ha^{-1} was obtained in treatment T3 followed by T1 (820 kg ha^{-1}), T2 (804 kg ha^{-1}) and T5 (667 kg ha^{-1}) and lowest yield was observed in T4 (553 kg ha^{-1}). Similar trend was observed for haulm yield and harvest index. It was observed that, T1 achieved highest B:C ratio with 3.36 and followed by T3 with 3.27 with net returns Rs 39769 and Rs 52267 respectively. However, increase in net returns was Rs 12498 for T3 in comparison to T1. Increase in net returns for T3 was Rs 18851 and Rs 25471 compared to T2 and T5 respectively. Lowest B:C ratio of 1.50 was obtained for treatment T4. Highest increase in net income was Rs 39390 for T3 compared to T4.

Table 2 Detailed specifications of the stubble manager cum crop planter

S. No.	Particulars	Specifications
1.	Working width	1500 mm
2.	Overall dimensions (Length × Width × Height)	2000 × 2000 × 1000 mm
3.	Weight of the machine	810 kg
4.	Power requirement	41 kW
5.	Initial cost of machine	Rs 230000
Stubble managing unit		
6.	Number of working elements for mulching	10
7.	Type of flail blade	Inverted gamma type
8.	Radius of flail blade tip rotation	330 mm
9.	Number of working elements for strip-tillage	10
10.	Type of strip-till blade	L-type
11.	Radius of strip-till blade tip rotation	385 mm
12.	Number of flanges	5
13.	Speed of PTO-shaft	540 rpm
14.	Speed of rotor	1500 rpm
15.	Mode of power transmission to rotor	Belt and pulley
16.	Centre distance between two strip-till blades	300 mm
17.	Recommended forward speed	2.0 km h^{-1}
Crop planting unit		
18.	Type of planting unit	Fluted seed drill
19.	Crops suitable	Blackgram and greengram
20.	Working width of crop planting unit	1500 mm
21.	Type of seed metering mechanism	Fluted roller
22.	Seed rate designed	50 kg ha^{-1}
23.	Power transmission	Chain-sprocket drive
24.	Number of furrow openers	5
25.	Spacing in-between two furrow openers	300 mm
26.	Type of furrow opener	Inverted T-type
27.	Type furrow closer	Drag chain

Table 3 Specifications of the conventional seed drill

S. No.	Particulars	Specifications
1.	Type of equipment	Mounted type
2.	Power source	Tractor of 34 kW
3.	Type of seed metering mechanism	Fluted roller
4.	Crops suitable	Paddy, blackgram and Greengram
5.	Seed rate	40 - 60 kg ha^{-1}
6.	No. of furrow openers	9
7.	Spacing between two furrow openers	220 mm
8.	Type of furrow opener and closer	Shovel type, MS flat
9.	Overall dimensions (length × width × height)	2150 × 900 × 1150 mm
10.	Name of make	AP State Agros
11.	Cost of seed drill	Rs 70000

Table 4 Specifications of the rotary slasher

S.No	Particulars	Specifications
1.	Type of equipment	PTO driven, mounted type
2.	Power source	Tractor of 34 kW
3.	PTO input speed	540 rpm
4.	Working width	1500 mm
5.	Height of cut	25 – 150 mm
6.	Number of blades	3
7.	Blade speed	1012 rpm
8.	Guards	Rubber flap
9.	Overall dimensions (length × width × height)	1650 × 1950 × 975 mm
10.	Name of make	Shaktiman
11.	Cost of machine, Rs.	Rs 100000

Table 5 Specifications of the rotavator

S.No.	Particulars	Specifications
1.	Type of machine	PTO driven, mounted type
2.	Power source	Tractor of 34 kW
3.	PTO input speed	540 rpm
4.	Type of power transmission	Gear drive
5.	Number of flanges	8
6.	No. of blades per flange	6
7.	Number of working components	48
8.	Shape of blades	L-type
9.	Working width	1800 mm
10.	Working depth	100-120 mm
11.	Overall dimensions (length × width × height)	1950 × 2025 × 1125 mm
12.	Name of make	Maschio
13	Cost of machine,	Rs 100000

Table 6 Specifications of the cultivator

S.No.	Particulars	Specifications
1.	Type of equipment	Mounted type
2.	Power source	Tractor of 34 kW
3.	Working width	2025 mm
4.	Working depth	100 – 150 mm
5.	No. of tynes	9
6.	Tyne spacing	225 mm
7.	Type of shovel	Double point
8.	Depth of operation	100 – 120 mm
9.	Overall dimensions (length × width × height)	2050 × 900 × 1125 mm
10.	Name of make	AP State Agros
11.	Cost of cultivator	Rs 40000

Fig. 1 Broadcasting

Fig. 2 Stubble manger cum crop planter

Fig. 3 Conventional seed drill

Fig. 4 Rotary slasher

Fig. 5 Rotavator

Fig. 6 Cultivator

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