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DEVELOPMENT AND EVALUATION OF MULTI TOOLBAR NO-TILL DRILL WITH RESIDUE HANDLING DEVICE UNDER VARIOUS PADDY RESIDUE CONDITIONS

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***Abstract*:** A multi-toolbar no-till drill has been designed and developed which could work satisfactorily in combine harvested paddy fields. Performance evaluation of the machine was conducted for under three different paddy residue conditions, i.e. chopped paddy residue conditions spread loose straw conditions and tillage condition (control). The multi-toolbar no-till drill was compered powered coulter double disc type drill. The maximum effective field capacity of 0.45 ha·h^{-1} was found in Pantnagar no-till drill (M_4) followed by multi-toolbar no-till drill (M_1) as 0.39-0.42 ha·h^{-1}, multi-toolbar no-till drill with residue handling device (M_2) as 0.38 ha·h^{-1} and -powered coulter double disc type drill (M_3) as 0.34-0.33 ha·h^{-1}. The maximum field efficiency of 73.5 % was found in machine (M_4) followed by 68.75 to 70.83 % for machine (M_3), 63.5 to 63.8 % for machine (M_1) and 60.2 to 61.4 % for machine (M_2). The maximum plant emergence of 161 plants·m^{-2} was observed in case of treatment T_7. Highest yield of 5.8 t·ha^{-1} was observed in treatment T_3 where machine M_2 (multi-toolbar no-till drill with residue handling device) un-chopped residue condition. Almost similar yield was observed for the treatment T_1, T_3 and T_7 (control) as the same did not differ significantly at 5 % level of significance.

Keywords*: residue handling, no-till drill, sowing method, furrow opener, wheat sowing, field performance*

INTRODUCTION

Rice-wheat cropping system is very common in India. These two crops together contribute more than 70 % of the total cereal production in the country from an area of

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about 25 Mha under wheat (Anonymous, 2013) and about 44 Mha under rice (Kumar *et al*. 2014).

The loose straw delivered behind the combine harvesters poses many management problems. Residue management is receiving a great deal of attention because of its diverse and positive effects on physical, chemical and biological properties of soil. No-till drills of various makes could be used successfully for direct seeding the crop but loose residue hinders the smooth operation of these drills. Disc openers cause less soil disturbance than hoe openers because they create a narrower furrow (Munir, *et al*., 2012). The limitations of disc openers are less draft requirement but large vertical force for penetration. In addition, even where penetration is adequate, "hairpinning" (forcing of uncut straw or chaff into the furrow) may result in seed "pop-up" after the disc drill passes, thereby reducing seed-to-soil contact. Poor seed-to- soil contact interferes with germination and seedling establishment and is often responsible for poor stands in chaff rows.

The drills equipped with hoe, chisel, winged chisel or inverted "T" type furrow openers, give more positive depth control. In heavy crop residue or when row spacing is narrow, inverted T-type furrow openers is prone to blockage between the two adjacent openers, causing operators irritation as well as reducing field capacity.

Hence, for proper residue management in direct drilling of wheat, the main operational problem of straw accumulation in combine-harvested paddy field is to be solved. Keeping the above aspect in view the straw multi-toolbar no-till drill was designed and developed and present work was undertaken with the objective to "development and evaluate the field performance in sowing of wheat crop by the new machine under different paddy residue conditions".

MATERIAL AND METHODS

Straw Handling Device and its Attachment. It is a tractor mounted PTO operated machine with adjustable ground clearance residue collecting fingers. It is attached ahead of the no-till drill as an attachment. As the tractor moves forward, the loose straw is thrown over the already sown area and direct sowing operations could be performed simultaneously. A flat rubber belt of size 152 mm and thickness 7.2 mm has been used as the conveyor belt for the straw thrower. Drive and driven pulleys of 152 mm diameter and width 152 mm were selected and keyed to a shaft of 420 mm length and 25 mm diameter. V-belt sheave of 120 mm diameter was keyed to the shaft for transmitting power from main shaft drive pulley. Straw fingers of 170 mm length made of spring steel wires having 5 mm diameter were fitted on the flat belt at a spacing of 400 mm with each other. Power transmission shaft of 770 mm length made of mild steel (M S) rod of 35 mm diameter was used to transmit the power from tractor PTO to straw throw or assembly. Straw thrower assembly could be attached mounted with no-till drill by attaching it to ahead the front of multi tool bar no-till drill by clamps. Clamps are made of MS strips of dimensions 150 × 50 × 12 mm.

Multi Toolbar No-Till Drill. Main frame: Two angle irons of 50 × 5 mm size having 2092 mm length were welded together to form a square hollow section beam with a cross-section of 50 × 50 mm. In all, three beams of identical size with above mentioned specifications were fabricated. All the three beams were joined together in parallel position with another two side hollow square beams having cross-section of 40 × 40 mm to form a rectangular frame with overall length of 2092 mm and width 1830 mm respectively.

Seed and fertilizer box: The seed and fertilizer box of multi-toolbar no-till drill is made by using mild steel sheet. Both seed and fertilizer box is made of equal size and joint together in the centre along the length. The trapezoidal shaped seed and fertilizer boxes (top width 250 mm, bottom width 150 mm, depth 31 cm in centre and length of box 2500 mm) are made from 20 gauge M S sheet.

Depth control device: Depth control wheels are made from 80 mm wide and 6 mm thick M S flat with diameter 335 mm to support the equipment with in operation. It also provided a uniform depth of operation. Two such wheels have been provided to both sides of the frame. Depth of the wheel could be varied by holes in the arm and by adjusting the nut and bolts.

Power transmission unit: A ground wheel of 349 mm diameter with rim width 80 mm and thickness of 6 mm was fabricated from M.S. flat for power transmission. The wheel was provided with 4 spokes of M S flat (120 × 25 × 5 mm). 11 lug of spikes 100 × 50 × 5 mm size with tapered end were welded on the periphery. Two stage chain drive is provided from wheel to the main drive shafts and farther to fertilizer and seed metering units. In first stage, chain drive is provided from ground wheel to a counter shaft. In second stage drive was arranged from counter shaft to seed and fertilizer metering unit. The transmission ratio between ground wheel and seed and fertilizer metering unit is kept as 1:2. A floating arm is used to connect the ground wheel at rear right end of the main frame.

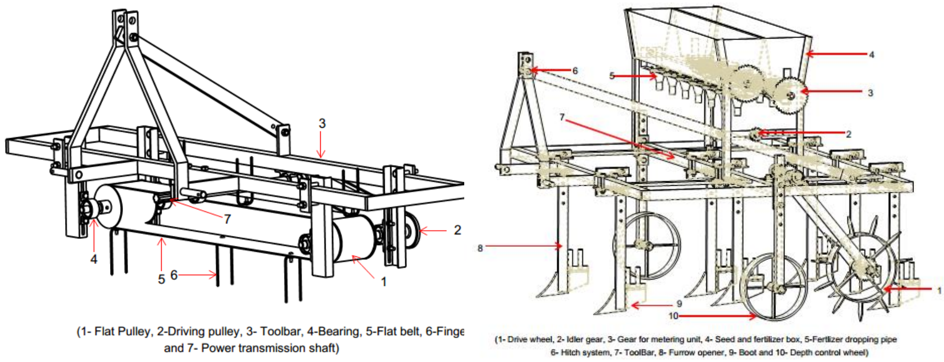

Figure 1. Isometric view of prototype residue handling device and multi toolbar no-till drill

Seed and fertilizer metering unit: The seed metering mechanism (flutted roller) is fitted under the bottom of seed box. Seven numbers of flutted rollers, having 12 numbers of flutes, with aluminium feed cups are fitted on a common shaft for metering the seed. Seed rate adjustment is obtained by sliding the flutted roller in or out into feed cups.

An adjustable orifice with agitator type fertilizer metering mechanism has been used, in the no-till drill, for metering of fertilizer. In this type of metering mechanism, fertilizer flow is regulated by changing the size of the opening provided on the movable (M S) flat at the bottom of the fertilizer box. A rubber agitator fixed above the opening in the fertilizer box helps in maintaining continuous flow of fertilizer. This mechanism was

adopted because of its ability to meter medium and small size fertilizer with fair accuracy, in design as well as its and simplicity with low cost.
Polyethylene tubes of 25 mm diameter and 2 mm thickness have been were used to convey seed from orifice to the furrow opener under gravity.

Furrow opener: Seven inverted-T type furrow openers are mounted to the frame of the drill with clamps. The overall height of the furrow opener is kept 720 mm which providing a clearance of 650 mm between ground and frame of the drill. The furrow opener is made from 8 mm thick high carbon bit welded to a mild steel plate. Furrow openers shank made of medium carbon steel flat with a 16×50 mm cross section. The rake angle is kept 28º in order to make a slit 3 to 5 cm in the soil. The relief angle of the blade is kept 8º. The furrow opener is welded to the shank in place of bolting it through nut and bolts.

Field performance and evaluation. Comparative field performance evaluation of the developed multi-toolbar no-till drill was carried out in different treatment at crop research center, G B Pant University of Agriculture and Technology, Pantnagar. Geographically, it is located at 29°N latitude and 79.29°E longitude and an altitude of 243.84 meter above mean sea level which is embodied with wet moisture regime and high water table conditions for most part of the year.

The soil of the experimental field is loam in texture, medium in organic carbon, medium in available phosphorus and high in available potassium. The soil pH values ranges between 7.2 and 7.3 which is slightly alkaline in nature. The soil organic carbon content varies from 0.62 to 0.68 %. The available phosphorus and potassium were observed as 37 and 180.5 kg/ha. The soil of the experimental field is silty clay loam with sand: silt: clay contents of 36.2:47.6:16.2 %. The average initial bulk density and moisture content were observed as 1.55 g/cc and 21.94 % (d.b) respectively, at the depth of 150 mm before conducting the experiment.

It was compared with other existing drill for wheat sowing and harvesting in experimental field on 8-Nov-2013 and 16-Aprail-2014 respectively. Trial was conducted to assess the machine and crop parameters including crop yield. Wheat variety (DWP-621-50) was sown in each experimental plot at recommended seed and fertilizer rate. The experiment was laid out in randomized block design with seven treatments and three replications each. The size of each plot was 28×4.5 m. The experiment was carried out with the following treatments:

T_1 - Un-chopped residue + multi-toolbar no-till drill
T_2 - Chopped residue+ multi-toolbar no-till drill
T_3 - Un-chopped residue + residue handling device + multi-toolbar no-till drill
T_4 - Chopped residue + residue handling device + multi-toolbar no-till drill
T_5 - Un-chopped residue+ Powered coulter double disc type drill
T_6 - Chopped residue + Powered coulter double disc type drill
T_7 - Control (conventional method of sowing)

Experiment was conducted to evaluate the machine performance, speed of operation, fuel consumption, draft, depth of sowing, field capacity, field efficiency, residue conveying efficiency, % and Residue flow percentage.

The crop parameters noted were germination count, tillering count, final plant stand, plant height, number of spikes, spike length, number of grains per spike, thousand grain weights and grain yield.

RESULTS AND DISCUSSION

Initial field condition. The bulk density of the soil was observed as 1.55 g/cc in un-chopped and chopped residue field and 1.31 g/cc after tilled field. Soil moisture content was observed as 21.94 % (db) in both in residue un-chopped and chopped field. The moisture content of soil was observed less in tilled field (19.56 %) in compared to chopped and un-chopped un-tilled field, because soil moisture reduced slightly during tillage operation.

The average loose residue load and anchored stubble load in the un-chopped residue field was observed as 0.789 and 1.870 kg/m^2 at an observed moisture content of 32.56 and 69.03 % (wb), respectively. The average residue load in the chopped residue field was observed as 1.950 kg/m^2 at an observed moisture content of 43.2 % (wb). The average clod mean weight diameter, in tilled field, was observed as 15.45 mm.

Field performance of no-till drill. The seven field treatment combination was sowing by four type no-till seed drill. The treatment T_1 and T_2 was sowing by Multi-toolbar no-till drill (M_1), treatment T_3 and T_4 by Multi-toolbar no-till drill with attached residue handling device (M_2), treatment T_5 and T_6 by Powered coulter double disc type drill (M_3) and treatment T_7 by Pantnagar no-till drill (M_4). The forward speed was recorded 3.2, 3.0, 3.8 and 4.05 km/h in the no-till drill M_1, M_2, M_3 and M_4 respectively (Table-1). The maximum fuel consumption was recorded as 3.54 l/h in Powered coulter double disc type drill (M_3) fallowed by 3.47, 3.31 and 3.26 l/h in multi-toolbar no-till drill (M_1), multi-toolbar no-till drill with attached residue handling device (M_2) and Pantnagar no-till drill (M_4) respectively.

The maximum depth of sowing of 7.0 cm was measured in treatment T_3 followed by 6.83, 6.7, 6.5, 5.7, 4.9, and 4.7 cm in treatment T_4, T_2, T_1, T_7, T_5 and T_6 respectively. Depth of sowing was observed more in no-till condition because of more depth of the slit opened by the no-till drill. The lower seed placement depth occurred in case of powered coulter double disc type no-till drill due to large amount of residue condition. The maximum effective field capacities of 0.45 ha/h was found in no-till drill (M_4) followed by M_1 (0.39-0.42 ha/h), M_2 (0.38 ha/h) and M_3 (0.34-0.33 ha/h) (Table:1). The maximum field efficiency of 73.5 % was found in machine (M_4) followed by 68.75 to 70.83 % in machine (M_3), 63.5 to 63.8 % in machine (M_1) and 60.2 to 61.4 % in machine (M_2). Residue conveying efficiency was found as 81.6 and 22.1 % in T_3 and T_4 treatments respectively. The minimum residue flow percentage was found as 78.56 % in T_1 treatment followed by 97.6 % in T_3, which was sown in un-chopped field conduction. In treatment T_2, T_4, T_5 and T_6, the residue flow percentage was found as 100 %.

The field condition directly affect the performance of machine, the higher speed of operation and field efficiency were found in treatment $T_{7,}$ which may be due to the field condition of control treatment was ideal for sowing of wheat crop. The multi-tool bar no-till drill was operated in no-till field with standing stubble and loose straw condition, due to the lower performance of machine was found in compare to existing no-till drill. The amount of residue into the field is directly related machine performance all the tested conditions. Other parameters affecting crop residue cutting ability of a no-till disc opener such as disc diameter, downward pressure, sowing depth, straw water content, and forward speed, must be taken into consideration. The effects of tillage on residue cover depend on the speed and depth of tillage operation, type of implement, soil conditions, type and amount of residues, and the height of standing stubbles**.**

Table 1. Field performance of different drills under various field conditions

Sl. No.	*Treatments*	T_1	T_2	T_3	T_4	T_5	T_6	T_7
1.	*Speed of operation, km/h*	*3.2*	*3.2*	*3.0*	*3.0*	*3.8*	*3.8*	*4.05*
2.	*Fuel consumption, l/h*	*3.31*	*3.31*	*3.47*	*3.47*	*3.54*	*3.54*	*3.26*
3.	*Draft, N*	*3045*	*3044.5*	*3288.2*	*3282*	*-*	*-*	*4600*
4.	*Depth of sowing, cm*	*6.5*	*6.7*	*7.0*	*6.83*	*4.9*	*4.7*	*5.7*
5.	*Field capacity, ha/h*	*0.39*	*0.42*	*0.38*	*0.38*	*0.34*	*0.33*	*0.45*
6.	*Field efficiency, %*	*63.5*	*63.8*	*60.2*	*61.4*	*68.75*	*70.83*	*73.5*
7.	*Residue conveying efficiency %*	*-*	*-*	*81.6*	*22.1*	*-*	*-*	*-*
8.	*Residue flow, %*	*78.56*	*100*	*97.6*	*100*	*100*	*100*	*-*

Effect on crop parameter. Plant emergence and final plant stand: The type of opener played a significant role in the speed of crop emergence (Table 2). The number of plants/m^2 (20 DAS) varied between 131.1 and 161.7. The maximum plant emergence of 161 plants/m^2 was observed in case of treatment T_7, followed by 151.3 plants/m^2 in $T_{2,}$ 148.7 plants/m^2 in T_4, 140.7 plants/m^2 in $T_{3,}$139.1 plants/m^2 in T_1 and T_5 and 131.7 plants/m^2 in T_6 respectively. The lower plant emergence occurred in treatment T_6 which may be due to minimum death of seed placement and slots were opened widely. By that fact the seeds were more exposed in the sun light. The highest plant emergence occurred in conventional sowing (T_7), which may be due to proper depth of seed placement and sore soil seed contact. In the presence of crop residue, the winged furrow opener created inverted T-shaped groove and the hoe-type furrow opener created U-shaped groove that resulted in greater number of seedling emergence, oxygen diffusion rates and earthworms activity than V-shaped groove created by the disk furrow opener. Saharawat et al. (2010) also reported about 15% higher effective tillers in Zero Tillage planter seeded wheat than Conventional Tillage Wheat.

Number of effective tillers and final plant stand: The effective tillering count was noted at 30, 60 and 90 DAS, and is shown in Table 2. The number of tillers/m^2 increased during the period between 30 and 60 DAS and then reduced in numbers for period between 60 and 90 DAS. The highest number of tillers/m^2 were observed for treatment T_7 (188.3 tillers/m^2) followed by T_1 (172 plants/m^2)$_,$ T_2 (166 plants/m^2), T_4 (161.7 plants/m^2)$_,$ T_5 (160.0 plants/m^2)$_,$ T_3 (155 plants/m^2)$_,$ and T_6 (145 plants/m^2)$_,$ respectively at 30 DAS. The tiller population differed significantly ($P<0.05$) from one another among different treatments at 60 DAS. The highest number of tillers/m^2 were observed as 443 in treatment T_7 followed by 388.7 in T_3, 373 in T_1, 371 in T_4, 370 in T_2, 341.7 in T_5 and 326.7 in T_6, respectively. The tiller population at 90 DAS in different treatments is sown in table 2. It is clear from LSD value that at 90 DAS also, the tillers population differed significantly ($P<0.05$). The highest number of tillers/m^2 was observed as 394 in treatment T_7, followed by 339 in T_1, 337 in T_3, 322 in T_2, 310 in T_4, 309 in T_5 and 297 in T_7, respectively.

Plant height: The maximum plant height was found as 24.9 cm in treatment T_3 at 30 DAS, it is significantly higher in comparison to control. At 60 and 90 DAS the maximum plant height was observed in treatment T_7 which were at par with the plant height in treatments $T_{1,}$ T_2, T_3, and T_4. Plant height in treatments T_5 and T_6 was found significantly lower in comparison to rest of the treatments where both the treatments differed non-significantly. Findings revealed that plant height was maximum recorded under conventional tillage. Similar results were also reported by LI Su *et al (*2006) and Singh *et al.* (2006). The possible reason of lower plant height under no-tillage with residue and standing stubble condition could be that crop under no-tillage condition received crop growth competition with standing stubble which might have reduced the plant height as compared to control condition.

Table 2. Effect of treatments on plant emergence and tillers

Treatment	*Number of Plant emergence/m^2 20 DAS*	*Number of effective tillers/m^2*		
		30 DAS	*60 DAS*	*90 DAS*
T1	*139.3*	*172.0*	*373.3*	*339*
T2	*151.3*	*166.7*	*370.0*	*322*
T3	*140.7*	*155.0*	*388.7*	*337*
T4	*148.7*	*161.7*	*371.7*	*310*
T5	*139.3*	*160.0*	*341.7*	*309*
T6	*131.7*	*145.0*	*326.7*	*297*
T7	*161.0*	*188.3*	*443.0*	*394*
LSD 5%	*16.7*	*19.7*	*27.8*	*18*

Table:3 Effect of treatments on crop growth parameters

Treatments	*Plant height, cm*			
	30 DAS	*60 DAS*	*90 DAS*	*At the time of harvesting*
T1	*24.3*	*42.1*	*72.1*	*90.4*
T2	*22.9*	*41.4*	*72.2*	*91.0*
T3	*24.9*	*40.0*	*70.5*	*91.3*
T4	*22.8*	*40.1*	*72.0*	*91.7*
T5	*19.4*	*38.2*	*66.9*	*84.0*
T6	*17.9*	*38.0*	*68.0*	*83.7*
T7	*18.3*	*42.5*	*76.9*	*96.0*
LSD at 5%	*3.4*	*NS*	*3.9*	*2.6*

NS-Non-significant

Yield and yield attributes. Number of spikes: The difference in number of spikes/m^2 for different treatments was significant. The average number of spikes/m^2 was highest in treatment T_7 (385.7 spikes/m^2), was performed by followed by T_3 (311.0 spikes/m^2), T_1 (305.0 spikes/m^2), T_2 (294.3 spikes/m^2), T_4 (288.7 spikes/m^2), T_5 (281.0 spikes/m^2) and T_6 (275.7 spikes/m^2). The higher spikes count in case of treatment T_7 (conventional sowing) may be due to the better seed placement as indicated by tillage operation and also highest plant emergence with higher tillering count at different stages of crop growth. Lower spikes count in treatment T_6 may be due to less plant emergence.

Spike length: Spike length was significant difference in spike length obtained in different treatments. The highest spike length of 9.8 cm is observed in case of treatment T_7 followed by T_5 (9.4 cm), T_1 and T_4 (9.3 cm), T_3 (9.2 cm), T_6 (9.0 cm) and T_2 (8.9 cm), respectively.

Number of grains per spike: Wheat crop establishment method had non-significant effect on grain count per spike in all the treatments. The treatment T_3 gave highest grain count (60.7 grains/spike) followed by treatments T_7 (58 grains/spike), T_1 (57 grains/spike), T_2 (55.0 grains/spike) T_4 (54.7 grains/spike), T_5 (45.3 grains/spike) and treatments T_6 (45.0 grains/spike) where all the treatments yielded statistically at par. The observation on spike length under all the establishment method produced non-significant results, which differed at 5 % level of significance.

Test (1000-grains) weight: The test weight was more in T_3 (47.5 g) followed by T_5 (46.5 g), T_7 (46.0 g), T_4 (45.5 g), T_2 (44.5 g), and treatment T_1 and T_7 (43.5 g). The difference was observed statistically significant at 5 % level of significance. Maximum test weight was recorded under T_3 which was significantly higher than T_7, T_1, T_2, and T_4 and at par with T_5 and T_6.

Table 4. Effect of various treatments on crop yield attributes

Treatments	*Number of spikes/ m^2*	*Spike length Cm*	*Number of grains/ spike*	*Test weight g*	*Grain yield t/ha*
T1	*305.0*	*9.3*	*57.3*	*43.5*	*5.5*
T2	*294.3*	*8.9*	*55.0*	*44.5*	*4.7*
T3	*311.0*	*9.2*	*60.7*	*47.5*	*5.8*
T4	*288.7*	*9.3*	*54.7*	*45.5*	*4.1*
T5	*281.0*	*9.4*	*45.3*	*46.5*	*3.8*
T6	*275.7*	*9.0*	*45.0*	*46.0*	*3.4*
T7	*385.7*	*9.8*	*58.0*	*43.5*	*5.6*
LSD at 5%	*21.8*	*NS*	*NS*	*2.4*	*0.6*

NS-Non-significant

Grain yield: Highest yield of 5.8 t/ha was observed in treatment T_3, where un-chopped residue combined with residue handling unit and multi-toolbar no-till drill followed by T_7 (5.6 t/ha), T_1 (5.5 t/ha), T_2 (4.7 t/ha), T_4 (4.1 t/ha), T_5 (3.8 t/ha), and T_6 (3.3 t/ha), respectively. Crop yield in T_3 and T_1 treatment was recorded non-significantly to the control. Higher grain yield was produced under treatment, where un-chopped residue field condition prevailed. This may be due to better crop establishment throughout the crop season resulting in higher plant stand at the time of harvesting, higher number of spikes/m^2 and higher 1000-grains weight. The better crop establishment in these treatments may also be due to decomposition of crop residue slowly as it maintained moisture level on the surface throughout the crop season. Spike length and plant height were high in case of using no-till drill with the residue manager, which increased the grain yield by 12.4 % more than using no-till drill without this attachment (Hegazy and Dhaliwal, 2011). Kumar *et al.* (2013) reported the grain yield in Zero Tillage Wheat was 6% and 10% higher than Rotovator Tillage Wheat and Conventional Tillage Wheat, whereas, lowest yield was observed in Reside Bed Planting Wheat. The grain yield of winter wheat was higher 11.65% in technologies which included mulch tillage system than conventional technologies (Kovacevic *et al.*, 2005).

CONCLUSION

The maximum effective field capacity of 0.45 ha/h was found in Pantnagar no-till drill (M_4) followed by multi-toolbar no-till drill (M_1) as 0.39-0.42 ha/h, multi-toolbar no-till drill with residue handling device (M_2) as 0.38 ha/h and -powered coulter double disc type drill (M_3) as 0.34-0.33 ha/h. The maximum field efficiency of 73.5 % was found in machine (M_4) followed by 68.75 to 70.83 % for machine (M_3), 63.5 to 63.8 % for machine (M_1) and 60.2 to 61.4 % for machine (M_2).

The maximum plant emergence of 161 plants/m^2 was observed in case of treatment T_7 followed by 151.3 in T_2, 148.7 in T_4, 140.7 in T_3, 139.1 in T_1 and T_5 and 131.7 plants/m^2 in T_6.

Highest yield of 5.8 t/ha was observed in treatment T_3 where machine M_2 (multi-toolbar no-till drill with residue handling device) un-chopped residue condition. This was followed by T_7 (5.6 t/ha), T_1 (5.5 t/ha), T_2 (4.7 t/ha), T_4 (4.1 t/ha), T_5 (3.8 t/ha) and T_6 (3.3 t/ha). Almost similar yield was observed for the treatment T_1, T_3 and T_7 (control) as the same did not differ significantly at 5 % level of significance.

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RAZVOJ I OCENA VIŠENAMENSKE SEJALICE ZA DIREKTNU SETVU SA UREĐAJEM ZA OBRADU OSTATAKA U RAZLIČITIM USLOVIMA

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***Sažetak*:** Višenamenska direktna sejalica konstruisana je i razvijena za rad na parcelama posle kombajniranja pirinča. Ocena performansi mašine je izvedena u tri različita stanja ostataka. Maksimalni efektivni poljski kapacitet od 0.45 $ha \cdot h^{-1}$ kod Pantnagar sejalice (M_4), zatim kod sejalice (M_1) 0.39-0.42 $ha \cdot h^{-1}$, sejalice sa uređajem za obradu ostataka (M_2) 0.38 $ha \cdot h^{-1}$ i sejalice sa reznim diskovima (M_3) 0.34-0.33 $ha \cdot h^{-1}$. Maksimalna efikasnost od 73.5 % je izmerena kod mašine (M_4), zatim 68.75 do 70.83 % kod mašine (M_3), 63.5 do 63.8 % kod mašine (M_1) i 60.2 do 61.4 % kod mašine (M_2). Najveći prinos od 5.8 $t \cdot ha^{-1}$ je izmeren u tretmanu T_3. Sličan prinos je bio kod tretmana T_1, T_3 i T_7 (kontrola).

***Ključne reči*:** *obrada ostataka, direktna setva, metod setve, otvarač brazed, setva žita, osobine parcele*

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