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WEED DYNAMICS AND PRODUCTIVITY OF MAIZE-WHEAT CROPPING SYSTEM AS INFLUENCED BY TILLAGE/PLANTING TECHNIQUES

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Abstract: A field experiment consisting of 16 treatment combinations of four tillage and planting methods *viz.* i) zero tillage, ii) seeding with multi-crop planter, iii) seeding with manual seed drill and iv) seeding after conventional tillage, each in maize and wheat was conducted at Palampur during *kharif* 2009 to *rabi* 2010-11. Weed flora in maize crop was mainly composed of *Ageratum conyzoides* L. (57 and 70%, at 60 and 90 DAS, respectively), *Polygonum alatum* L. (19 and 10%, respectively) and *Commelina benghalensis* L. (7 and 6%, respectively), *Echinochloa colona* (L.) Link*, Panicum dichotomiflorum* L.*, Eleusine indica* L., *Digitaria sanguinalis* L. and *Cyperus* spp. were the other weeds as a whole constituted 17 and 14%, respectively. Manual seed drill in *kharif* remaining at par with multi-crop planter resulted in significantly lower count of *A. conyzoides* and other weeds as compared to zero tillage (204.5 m^{-2}) at 60 DAS. Similarly, manual seed drill in *rabi* remaining at par with conventional tillage gave significantly lower count of *A. conyzoides* as compared to zero tillage and multi-crop planter. Zero tillage in *kharif* resulted in significantly highest *P. alatum* L. dry weight (4.58 g m^{-2}) at 90 DAS. Weed flora in wheat was composed of *Vicia sativa* L. (38 and 39% during 2009-10 and 2010-11, respectively), *Lolium temulentum* L. (25 and 30%), *Avena ludoviciana* Durieu (25 and 15%), *Anagallis arvensis* L. (8 and 15%) and *Phalaris minor* Retz. (4 and 8%) at 90 DAS. Zero tillage in *kharif* produced significantly higher population of *P. minor* (8.2 m^{-2}) over manual seed drill and conventional seeding. Zero tillage in *rabi* resulted in significantly highest count of *V. sativa* (61.2 m^{-2}) and *A. arvensis* (29.8 m^{-2}) over other treatments. Since weed competitive stress was taken care from time to time, maize green cob and stover yield; and wheat grain and straw yield were comparable under the treatments. Conventional tillage in *kharif* and *rabi* resulted in higher employment (165.3 and 170.4 mandays, respectively) over other treatments.

Keywords: Conventional tillage, Employment, Maize-wheat, Weed count, Zero tillage.

INTRODUCTION

Out of 30 major cropping systems identified in India (Yadav and Prasad, 1998), maize based cropping system is predominant in rainfed hilly areas, of which maize-wheat is the dominant cropping system. The contribution of this cropping system to total food grain

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production of the country is considerably large (GoI, 2012). In Himachal Pradesh, the system is taken on 70% of net sown area (Saroch *et al.,* 2012), mostly under rainfed conditions as 80% of cultivated area lacks irrigation facilities. Traditionally, maize and wheat are grown by broadcast seeding after 2-3 tillage operations. The traditional practice of growing these crops is laborious, costly and time consuming. Traditional tillage practices also contribute to the energy and labour cost in crop production system resulting in lower economic returns (Saharawat *et al.,* 2010; Kumar *et al.,* 2013). Furthermore, intensive ploughing results to a decrease in soil organic matter due to acceleration of the oxidation and breakdown of organic matter and ultimately degradation of soil properties (Gathala *et al.,* 2011). It also leads to compaction and eventually soil loss through wind and water erosion (Holland, 2004). Labour limitations, especially for weeding and low levels of mechanization for both land preparation and weeding also lead to a reduction in yield of crops.

Crop losses due to weed competition throughout the world as a whole, are greater than those resulting from combined effect of insect-pests and diseases (Hassan *et al*., 2005). Tillage operations can have a major impact on the distribution of the weed flora, weed seeds and propagules in soil, because soil disturbance regimes are related to seed distribution and viability (Lutman *et al.,* 2002), seed emergence (Grundy *et al.,* 1999), seedling survival (Mohler and Callaway, 1992), seed production (Mohler and Callaway, 1995) and also vegetative survival and dispersal over crops in the case of perennial weeds (Stevenson *et al.,* 1998). The effects of tillage frequently interact with those of rotation also. The present study was, therefore, undertaken with the objectives to evaluate the effect of tillage/planting management techniques and their interaction on weed dynamics and productivity of maize-wheat cropping system**.**

MATERIALS AND METHODS

An experiment was conducted at the Agronomy Farm of the CSK HPKV, Palampur ($32^0 6'$ N latitude, $76^0 3'$ E longitude and 1290 m mean sea level) in the North-West Himalayas during *kharif* 2009 to *rabi* 2010-11. The site falls in the Sub-Temperate Mid Hill Zone of Himachal Pradesh. The soil of the experimental field was silty clay loam in texture, moderately acidic in reaction (pH 5.06), high in organic carbon (1.1%) and phosphorus (25.8 kg ha^{-1}) and medium in available N (323.0 kg ha^{-1}) and K (276.4 kg ha^{-1}).

Maize-wheat was grown in sequence with 16 treatment combinations in strip plot design with three replications. Treatments in horizontal plots (Maize, *kharif*) were M_1 – Sowing by power tiller operated zero till drill, M_2 – Sowing by power tiller operated multi-crop planter, M_3 –

Sowing by manually operated seed drill, M_4 – Sowing by conventional method (sowing behind the hand plough) and in vertical plots (Wheat, *rabi*) W_1 – Sowing by power tiller operated zero till drill, W_2 – Sowing by power tiller operated multi-crop planter, W_3 – Sowing by manually operated seed drill, W_4 – Sowing by conventional method (sowing behind the hand plough). Before the present field experimentation, the site was under rice-wheat experiment under similar set of condition's and same layout. Maize 'Girija composite' and wheat 'HPW 155' were sown during both the years under irrigated conditions. The recommended dose of N, P_2O_5 and K_2O for maize and wheat was 120:60:40 and 120:60:30 kg ha^{-1}, respectively. Entire P and K were applied at sowing to both the crops. In maize, N was applied in three equal splits (at sowing, knee high and tasseling stage) whereas in wheat, half N at the time of sowing and remaining N was applied in two splits at tillering and earing stage. To control the weeds atrazine at 1.25 kg ha^{-1} followed by (*fb.*) 2,4-D at 1.00 kg ha^{-1} in maize crop and isoproturon at 1.20 kg ha^{-1} *fb.* 2,4-D at 1.00 kg ha^{-1} in wheat crop were applied during both years. However, at later growth period of crops, weeds were also removed manually. The weed density and weed dry weight data were analyzed after subjecting the original data to square root transformation ($\sqrt{x + 0.5}$). The treatment effects were compared using transformed means. Since data obtained over the year done at same experimental site, pooling was done over the seasons and mean data are given. The data obtained were statistically analyzed as per Gomez and Gomez, (1984). Weed infestation (%) and weed intensity (%) were worked out as per Rana and Kumar, (2014) as below:

$$\text{Weed infestation (\%)} = \frac{\text{Weed species population}}{\text{Total weed population}} \text{ x } 100$$

$$\text{Weed intensity (\%)} = \frac{\text{Weed population}}{\text{Weed+Crop population}} \text{ x } 100$$

RESULTS AND DISCUSSION

Weed Studies in Maize

Tillage/planting management practices greatly influence the composition, distribution, type and duration of weed flora associated in a particular cropping situation. In the present study, maize crop was predominantly infested with a large number of weeds which directed keen attention for their elimination from time to time during the crop growth. Weed flora in maize crop was mainly composed of *Ageratum conyzoides* L. (57 and 70%, respectively at 60 and 90 DAS), *Polygonum alatum* L. (19 and 10%, respectively) and *Commelina benghalensis* L. (7 and 6%, respectively). The other weeds (*Echinochloa colona* (L.) Link, *Panicum dichotomiflorum* L., *Eleusine indica* L., *Digitaria sanguinalis* L. and *Cyperus* spp.) as a whole

constituted 17 and 14%, respectively at 60 and 90 DAS. Chopra and Angiras, (2010) have also reported the association of these weeds with maize crop.

Table 1 revealed that tillage methods in *kharif* significantly influenced the count of *A. conyzoides* and others (*E. colona, P. dichotomiflorum*, *E. indica, D. sanguinalis* and *Cyprus* spp.) at 60 DAS. Manual seed drill (M_3) remaining at par with multi-crop planter (M_2) resulted in significantly lower count of *A. conyzoides* as compared to zero tillage (M_1), which produced significantly higher weeds and remained at par with conventional seeding (M_4). Similarly, zero tillage (M_1) resulted in significantly highest population of other weeds; however, the conventional tillage (M_4) remaining at par with multi-crop planter (M_2) and manual seed drill (M_3) gave significantly lower count. Tillage methods in *rabi* also significantly influenced the count of *A. conyzoides* at 60 DAS. Manual seed drill (W_3) remaining at par with conventional tillage (W_4) gave significantly lower count as compared to zero tillage (W_1) and multi-crop planter (W_2). This may be due to large number of weed seeds present on the soil surface. The result confirms the findings of Arif *et al.,* (2007) and Cardina *et al.,* (2002).

Tillage/planting management methods in *kharif* significantly influenced the dry weight of *P. alatum* at 90 DAS (Table 2). Manual seed drill (M_3) remaining at par with conventional seeding (M_4) and multi-crop planter (M_2) resulted in significantly lower *P. alatum* dry weight than zero tillage (M_1) which resulted in highest dry weight. However, tillage/planting techniques in *rabi* did not affect the dry weight of different weeds at both the stages. Weed infestation was not significantly affected by tillage/planting methods in *kharif* and *rabi* at maximum weed population stage *i.e.* 90 DAS (Table 3); however zero tillage (M_1) in *kharif* remaining at par with multi-crop planter (M_2) resulted in significantly higher weed intensity as compared to others.

Weed Studies in Wheat

A critical look at the data (Table 4) indicated that at maximum weed population stage (90 DAS), the weed flora was composed of *Vicia sativa* L. (38 and 39% during 2009-10 and 2010-11, respectively), *Lolium temulentum* L. (25 and 30%), *Avena ludoviciana* Durieu (25 and 15%), *Anagallis arvensis* L. (8 and 15%) and *Phalaris minor* Retz. (4 and 8%). Tillage/planting techniques in *kharif* significantly influenced *P. minor* count at 90 DAS. Zero tillage (M_1) remaining at par with multi-crop planter (M_2) resulted in its significantly higher population over manual seed drill (M_3) and conventional seeding (M_4).

Tillage/planting methods in *rabi* significantly influenced the weed population of *V. sativa* and *A. arvensis* at 90 DAS (Table 4). Zero tillage (W_1) resulted in significantly highest count of *V. sativa* and *A. arvensis* over other treatments. Higher populations in zero tillage may be due to higher weed seeds in these plots and lower crop population which facilitate luxurious growth of these weeds.

Tillage/planting methods in *kharif* did not significantly influence the dry weight of weeds. However, tillage methods in *rabi* significantly influenced the dry weight of *V. sativa* L. and *A. arvensis* at 90 DAS (Table 5). Zero tillage (W_1) resulted in significantly highest dry weight of *V. sativa* and *A. arvensis* over the other treatments. Table 6 revealed that tillage methods in *kharif* neither significantly affected the weed infestation nor weed intensity at 90 DAS. However, manual seed drill (W_3) in *rabi* resulted in significantly highest infestation of *L. temulentum*. Similarly, conventional tillage (W_4) remaining at par with multi-crop planter (W_2) and manual seed drill (W_3) resulted in higher infestation of *A. ludoviciana* as compared to zero tillage (W_1).

Yield and Employment

Table 7 revealed that inspite of little variation in weed population, tillage/planting methods during *kharif* and *rabi* did not significantly influence the yield of maize at harvest. Green cob and stover yield were comparable between different treatments. The comparable yield under different tillage treatments was also reported by Ram *et al.,* (2010). Like maize cob yield, wheat grain and straw yield was not significantly different either owing to tillage treatments in *kharif* or in *rabi*. This comparable effect of tillage and planting treatments suggested that farmer's can follow any method of his choice atleast for the initial years. The data on employment (days ha^{-1} $annum^{-1}$) in maize-wheat cropping system have also been presented in Table 7. Effect of tillage/planting techniques in *kharif* showed that conventional tillage (M_4) resulted in higher employment followed by manual seed drill sowing (M_3). Numbers of mandays employed under zero tillage (M_1), multi-crop planter (M_2), manual seed drill (M_3) and conventional seeding (M_4) in maize-wheat system were 156.3, 153.8, 159.3 and 165.3, respectively. Therefore, with zero tillage there was a saving of about 9 mandays as compared to conventional tillage. With multi-crop planter and manual seed drill, saving in mandays engaged were 11.5 and 6 days ha^{-1} $annum^{-1}$, respectively. Similar results were obtained with tillage/planting techniques in *rabi* crop. Number of mandays engaged under zero tillage (W_1), multi-crop planter (W_2), manual seed drill (W_3) and conventional seeding (W_4) were 148.4, 154.4, 161.4 and 170.4, respectively. This showed that with zero tillage there was a saving of

about 22 mandays as compared to conventional tillage. With multi-crop planter and manual seed drill, saving in mandays engaged was 16 and 9 days ha^{-1} $annum^{-1}$, respectively.

CONCLUSION

From the present study, it can be concluded that zero tillage in maize as well as in wheat crop produced higher weed population, weed dry weight and weed intensity as compared to other treatments. This high density of weeds did not reflect in maize and wheat yield. The labour employment was less in zero tillage as compared to other treatments. Therefore, total mandays saving in maize crop with zero tillage, multi-crop planter and manual seed drill was 9, 11.5 and 6 days ha^{-1} $annum^{-1}$, respectively. However, in wheat crop, there was a saving of 22, 16 and 9 days ha^{-1} $annum^{-1}$ with zero tillage, multi-crop planter and manual seed drill, respectively over conventional tillage. Thus the saved labour can be put in other farm operations.

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Table 1: Effect of treatments on count (no. m^{-2}) of weeds in maize at 60 and 90 DAS during 2009 and 2010 (Pooled data of 2 years)

Treatments	*A. conyzoides*		*C. benghalensis*		*P. alatum*		Others*	
	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS
Kharif								
Zero tillage (M_1)	14.3	16.6	4.3	4.5	7.5	6.4	7.5	7.2
	(204.5)	(273.8)	(19.0)	(20.8)	(56.7)	(41.0)	(56.7)	(52.2)
Multi-crop planter	12.0	17.0	4.6	5.2	6.6	6.1	6.7	7.4
(M_2)	(144.0)	(289.7)	(21.5)	(28.0)	(44.8)	(37.5)	(44.8)	(56.3)
Manual seed drill	11.9	15.7	3.8	4.9	6.9	6.1	6.9	8.2
(M_3)	(143.0)	(248.8)	(15.3)	(24.5)	(48.0)	(37.8)	(47.8)	(69.2)
Conventional tillage	13.2	16.5	4.8	4.8	7.3	6.3	6.6	6.8
(M_4)	(174.3)	(272.5)	(23.2)	(23.2)	(54.2)	(39.2)	(43.3)	(47.2)
LSD (P=0.05)	1.2	NS	NS	NS	NS	NS	0.5	NS
Rabi								
Zero tillage (W_1)	13.5	16.5	3.9	4.5	7.3	6.3	6.9	7.5
	(185.2)	(273.2)	(15.8)	(20.5)	(53.5)	(40.0)	(48.3)	(58.2)
Multi-crop planter	13.0	16.6	4.4	4.8	7.0	5.8	7.1	7.6
(W_2)	(170.3)	(277.3)	(20.3)	(23.2)	(50.0)	(33.3)	(50.3)	(58.8)
Manual seed drill	12.4	16.4	4.5	5.3	6.8	6.3	6.9	7.0
(W_3)	(153.7)	(269.3)	(20.5)	(28.7)	(46.8)	(39.3)	(47.2)	(50.3)
Conventional tillage	12.5	16.3	4.7	4.9	7.3	6.6	6.8	7.5
(W_4)	(156.7)	(265.0)	(22.3)	(24.2)	(53.3)	(42.8)	(46.8)	(57.5)
LSD (P=0.05)	0.6	NS	NS	NS	NS	NS	NS	NS

**E. colona, P. dichotomiflorum, E. indica, D. sanguinalis* and *Cyprus* spp.
Figures in parentheses are the averages of original values

Table 2: Effect of treatments on dry weight (g m^{-2}) of weeds in maize at 60 and 90 DAS during 2009 and 2010 (Pooled data of 2 years)

Treatments	*A. conyzoides*		*C. benghalensis*		*P. alatum*		Others*	
	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS
Kharif								
Zero tillage (M_1)	2.52	5.77	2.00	2.73	2.29	4.52	2.78	4.48
	(5.93)	(33.22)	(3.87)	(7.30)	(4.81)	(20.36)	(7.48)	(20.29)
Multi-crop planter	2.28	6.06	2.00	3.14	2.25	3.97	2.40	4.71
(M_2)	(4.79)	(37.41)	(3.74)	(9.75)	(4.65)	(15.60)	(5.43)	(21.93)
Manual seed drill	2.16	5.45	1.92	2.95	2.29	3.58	2.57	4.76
(M_3)	(4.31)	(29.46)	(3.58)	(8.44)	(4.79)	(12.69)	(6.25)	(22.57)
Conventional tillage	2.25	6.10	2.12	3.14	2.34	3.85	2.56	4.67
(M_4)	(4.70)	(37.05)	(4.14)	(9.77)	(5.02)	(14.69)	(6.15)	(21.69)
LSD (P=0.05)	NS	NS	NS	NS	NS	0.54	NS	NS
Rabi								
Zero tillage (W_1)	2.34	5.66	1.85	2.86	2.35	3.78	2.47	4.54
	(5.20)	(31.72)	(3.17)	(8.24)	(5.07)	(14.24)	(5.71)	(20.59)
Multi-crop planter	2.38	6.19	1.95	2.84	2.25	3.92	2.71	4.80
(W_2)	(5.23)	(38.48)	(3.79)	(7.82)	(4.61)	(15.26)	(7.09)	(23.02)
Manual seed drill	2.15	5.96	2.18	3.08	2.27	4.09	2.59	4.41
(W_3)	(4.24)	(35.69)	(4.46)	(9.30)	(4.75)	(16.85)	(6.41)	(19.37)
Conventional tillage	2.33	5.57	2.06	3.18	2.30	4.13	2.54	4.87
(W_4)	(5.06)	(31.25)	(3.91)	(9.90)	(4.83)	(16.99)	(6.10)	(23.51)
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

**E. colona, P. dichotomiflorum, E. indica, D. sanguinalis* and *Cyprus* spp.
Figures in parentheses are the averages of original values

Table 3: Effect of treatments on weed infestation (%) and weed intensity (%) at 90 DAS maize (Pooled data of 2 years)

Treatments	Weed infestation (%)				Weed intensity (%)
	A. conyzoides	*C. benghalensis*	*P. alatum*	Others*	
Kharif					

Zero tillage (M_1)	70.6	5.4	10.6	13.5	98.2
Multi-crop planter (M_2)	70.1	7.0	9.2	13.8	98.1
Manual seed drill (M_3)	65.4	6.4	10.0	18.2	98.0
Conventional tillage (M_4)	71.2	6.0	10.4	12.5	98.0
LSD (P=0.05)	NS	NS	NS	NS	0.2
Rabi					
Zero tillage (W_1)	69.3	5.2	10.4	15.1	98.1
Multi-crop planter (W_2)	70.7	5.9	8.5	14.9	98.1
Manual seed drill (W_3)	69.3	7.5	10.2	13.0	98.1
Conventional tillage (W_4)	67.9	6.1	11.1	14.8	98.0
LSD (P=0.05)	NS	NS	NS	NS	NS

**E. colona, P. dichotomiflorum, E. indica, D. sanguinalis* and *Cyprus* spp.

Figures in parentheses are the averages of original values

Table 4: Effect of treatments on count (no. m^{-2}) of weeds at 90 DAS in wheat (Pooled data of 2 years)

Treatments	*V. sativa*	*L. temulentum*	*A. arvensis*	*P. minor*	*A. ludoviciana*
Kharif					
Zero tillage (M_1)	5.1	4.5	1.9	2.6	3.4
	(26.7)	(20.2)	(8.2)	(8.2)	(11.8)
Multi-crop planter (M_2)	5.9	4.7	1.6	2.5	4.6
	(36.5)	(23.2)	(4.8)	(7.0)	(21.8)
Manual seed drill (M_3)	5.3	5.1	1.8	1.6	4.5
	(30.5)	(27.8)	(10.5)	(3.7)	(21.8)
Conventional tillage (M_4)	6.3	4.9	1.6	1.9	3.5
	(42.5)	(26.0)	(6.3)	(3.8)	(14.0)
LSD (P=0.05)	NS	NS	NS	0.7	NS
Rabi					
Zero tillage (W_1)	7.6	4.8	4.7	2.4	3.8
	(61.2)	(24.5)	(29.8)	(6.7)	(15.7)
Multi-crop planter (W_2)	4.9	4.4	0.7	2.5	4.1

	(24.3)	(20.3)	(0.0)	(7.3)	(17.8)
Manual seed drill (W_3)	4.9	5.7	0.7	2.0	4.0
	(24.2)	(33.3)	(0.0)	(4.8)	(18.3)
Conventional tillage (W_4)	5.1	4.2	0.7	1.8	4.1
	(26.5)	(19.0)	(0.0)	(3.8)	(17.7)
LSD (P=0.05)	1.0	NS	3.1	NS	NS

Figures in parentheses are the averages of original values

Table 5: Effect of treatments on dry weight (g m^{-2}) of weeds at 90 DAS in wheat (Pooled data of 2 years)

Treatments	*V. sativa*	*L. temulentum*	*A. arvensis*	*P. minor*	*A. ludoviciana*
Kharif					
Zero tillage (M_1)	2.16	2.62	1.29	2.10	3.44
	(4.39)	(7.01)	(2.79)	(4.51)	(12.28)
Multi-crop planter (M_2)	2.33	2.41	1.22	1.85	4.05
	(5.51)	(5.58)	(1.72)	(3.24)	(17.08)
Manual seed drill (M_3)	2.13	2.83	1.18	1.23	3.52
	(4.52)	(8.19)	(2.10)	(1.59)	(12.63)
Conventional tillage (M_4)	2.53	3.14	1.11	1.62	3.06
	(6.78)	(10.52)	(1.60)	(2.57)	(10.63)
LSD (P=0.05)	NS	NS	NS	NS	NS
Rabi					
Zero tillage (W_1)	3.20	2.78	2.66	1.85	3.47
	(10.51)	(8.02)	(8.16)	(3.63)	(12.55)
Multi-crop planter (W_2)	2.03	2.41	0.71	1.85	3.33
	(3.82)	(5.84)	(0.00)	(3.37)	(12.25)
Manual seed drill (W_3)	1.93	3.09	0.71	1.55	3.42
	(3.34)	(9.63)	(0.00)	(2.45)	(12.77)
Conventional tillage (W_4)	1.98	2. 71	0.73	1.54	3.86
	(3.53)	(7.81)	(0.04)	(2.46)	(15.04)
LSD (P=0.05)	0.44	NS	1.14	NS	NS

Figures in parentheses are the averages of original values

Table 6: Effect of treatments on weed infestation (%) and weed intensity (%) at 90 DAS wheat (Pooled data of 2 years)

Treatments	Weed infestation (%)					Weed intensity (%)
	V. sativa	*L. temulentum*	*A. arvensis*	*P. minor*	*A. ludoviciana*	
Kharif						
Zero tillage (M_1)	145.9	29.3	6.4	9.8	18.0	19.76
Multi-crop planter (M_2)	156.9	24.5	3.5	7.1	25.6	23.28
Manual seed drill (M_3)	139.9	29.8	5.3	5.3	24.7	24.19
Conventional tillage (M_4)	190.6	30.2	2.8	4.6	14.8	21.30
LSD (P=0.05)	NS	NS	NS	NS	NS	NS
Rabi						
Zero tillage (W_1)	189.3	17.3	18.0	5.2	12.2	31.72
Multi-crop planter (W_2)	145.2	28.7	0.0	10.1	24.9	16.92
Manual seed drill (W_3)	130.7	40.1	0.0	6.2	21.0	21.53
Conventional tillage (W_4)	168.0	27.6	0.0	5.3	25.1	18.37
LSD (P=0.05)	NS	6.9	NS	NS	6.7	NS

Table 7: Effect of treatments on yield and employment under maize-wheat cropping system (Pooled data of 2 years)

Treatments	Maize		Wheat		Employment (days ha^{-1} $annum^{-1}$)
	Green cob yield (t ha^{-1})	Stover yield (t ha^{-1})	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	
Kharif					
Zero tillage (M_1)	6.49	45.43	3.58	5.01	156.3
Multi-crop planter (M_2)	7.40	42.77	3.54	5.07	153.8
Manual seed drill (M_3)	8.06	44.01	3.58	5.28	159.3
Conventional tillage (M_4)	7.39	45.45	3.67	5.39	165.3
CD (P=0.05)	NS	NS	NS	NS	-
Rabi					
Zero tillage (W_1)	7.20	43.98	3.30	4.89	148.4
Multi-crop planter (W_2)	7.41	45.27	3.88	5.38	154.4
Manual seed drill (W_3)	7.66	43.45	3.56	5.09	161.4
Conventional tillage (W_4)	7.07	44.96	3.63	5.38	170.4
CD (P=0.05)	NS	NS	NS	NS	-