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Research Article

Effect of Weed and Tillage Management Practices on Growth and Yield of Pearl Millet (*Pennisetum glaucum*) - Mustard (*Brassica juncea*) Cropping System

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ABSTRACT

The present investigation entitled "Weed and tillage management practices on growth and yield of pearl millet (Pennisetum glaucum) - mustard (Brassica juncea) cropping system" was conducted during kharif & rabi seasons of 2015-16 & 2016-17 at Research Farm, RVSKVV, College of Agriculture; Gwalior (M.P.). The experiment consisted of 15 treatment combinations comprising 5 tillage practices viz. Conventional tillage (kharif & rabi), Conventional tillage (kharif) & Zero tillage (rabi), Zero tillage (kharif & rabi), Zero tillage (kharif) & Zero tillage + Crop residue (rabi) and Zero tillage + Crop residue (kharif & rabi) as horizontal plots and 3 weed management practices viz. RD of herbicide (Atrazin @0.5 kg ai/ha PE+2,4-D@0.5 kg ai/ha EPoE) kharif & (IPU @0.75 kg ai/ha PE or Oxydairgly @0.25 kg ai/ha PE) rabi season, IWM (Atrazin@0.5 kg ai/ha PE+1 HW at 25DAS) kharif & (Pendimethalin@1.0 kg ai/ha +1 HW at 25 DAS) in rabi season and Weedy check (kharif and rabi season) as vertical plots laid out in strip plot design with three replications. All recommended practices were followed during crop growing season. The interaction of Conventional Tillage (kharif season) & Zero Tillage (rabi season) with IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) kharif & (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in rabi season registered significantly effective value of weed parameters, crop growth parameters, yield attributes and computed parameters; while the minimum value was recorded under interaction of Zero Tillage (kharif and rabi season) with Weedy check (kharif and rabi season) over rest of the interactions.

Key words: *Growth parameters, Mustard, Pearl millet, Tillage practices, Weed management practices and Yield.*

INTRODUCTION

Pearl millet - mustard have been most important system of arid and semi-arid regions of Rajasthan, Haryana, Uttar Pradesh and Madhya Pradesh, where increasing in irrigation facilities have made it possible to grow these crops in sequence. Pearl millet is a stable diet for the vast majority of poor farmers and also forms an important fodder crop for livestock population in arid and semi-arid regions of India[13].

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Tillage creates soil environment favourable for plant growth. Soil tillage is one of the fundamental operations in agriculture because its influence on soil properties (physical, chemical and biological), environment and crop growth. Since continuous soil tillage strongly influence the soil properties, it is important to apply appropriate tillage practices that avoid the degradation of soil structure, maintain crop yield as well as ecosystem stability. Indian mustard (*Brassica juncea* L. Czernj. & Coss.) is the second largest oilseed crop in India after soybean. It is a diverse type of plants; which is grown as vegetables, spices, fodder for animal and source of oils and condiments, and take part in our agriculture economy by production[2]. Indian mustard is particularly being deep rooted and is able to utilize the soil moisture and nutrients from lower layers of the soil. Therefore, they are mostly grown under rainfed condition at residual soil moisture. Weeds have a greater genetic diversity than crops. Consequently, if a resource (light, water, nutrients or carbon dioxide) changes within the environment, it is more likely that weeds will show a greater growth and reproductive response. These characteristic makes the weed more efficient and vigorous than crops for utilization of natural resources. Tillage operation can have a major impact on the distribution of weed seeds in the soil on survival[9]. Tillage as a filter is constraints that influences weed species and weed seed distribution in the soil seed bank. The type of tillage implement and concomitant cultivation can significantly impact the weed seed distribution and composition in the soil surface[7]. Residue management and zero tillage are helpful to maintain soil moisture, increase the nutrient availability and reducing the weed population by creating physical barrier of sunlight. Conservation tillage practices (zero tillage+mulching) are a viable approach to retain soil moisture and nutrients under semi-arid dryland situations[1]. Cropping practice (tillage) is an important management tool for tackling water induced erosion hazard, promoting in-situ water conservation and improving, stabilizing crop yields from rainfed production systems of semiarid and subtropical regions[8].

MATERIALS AND METHODS

The experiment was conducted at the Research Farm, RVSKVV, College of Agriculture; Gwalior (M.P.) during *kharif* & *rabi* seasons of 2015-16 & 2016-17 under the edaphic and climatic conditions of Gwalior (26°13' North latitude and 78°14' East longitude with an altitude of about 206 m above mean sea level). The topography of the field was almost uniform with the very slight slope from East to West direction along with good drainage. The experiment consisted of 15 treatment combinations comprising 5 tillage practices viz. Conventional tillage (*kharif* & *rabi*), Conventional tillage (*kharif*) & Zero tillage (*rabi*), Zero tillage (*kharif* & *rabi*), Zero tillage (*kharif*) & Zero tillage + Crop residue (*rabi*) and Zero tillage + Crop residue (*kharif* & *rabi*) as horizontal plots and 3 weed management practices viz. RD of herbicide (Atrazin @0.5 kg ai/ha PE+2,4-D@0.5 kg ai/ha EPoE) *kharif* & (IPU @0.75 kg ai/ha PE or Oxydairgly @0.25 kg ai/ha PE) *rabi* season, IWM (Atrazin@0.5 kg ai/ha PE+1 HW at 25DAS) *kharif* & (Pendimethalin@1.0 kg ai/ha +1 HW at 25 DAS) in *rabi* season and Weedy check (*kharif* and *rabi* season) as vertical plots laid out in strip plot design with three replications. Size of each net plot was 6.0 m x 5.2 m. The soil of experimental field was sandy clay loam with pH 7.50 and EC 0.40 dS/m. For ensuring good germination, healthy and good quality seeds were used with 6 kg/ha. The nutrients were applied @80 kg N/ha, 40 kg P_2O_5/ha and 20 kg K_2O/ha. Urea (46% N), di-ammonium phosphate (18% N & 46% P_2O_5) and muriate of potash (60% K_2O) were used as a source of nitrogen, phosphorus and potash; respectively. Half of the nitrogen was applied at sowing time as basal dose along with the full quantities of phosphorus and potash. The remaining half of nitrogen was applied at 30 DAS. All recommended practices were followed during crop growing season.

RESULTS AND DISCUSSION

The results are describes on the basis of two years pooled data (Table 1 & 2).

Response observed in Pearl Millet:

❖ **Tillage Practices (T)**

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) significantly reduced value of total weed population in comparison to rest of the treatments followed by Conventional Tillage (*kharif* and *Rabi* season).

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) registered significantly effective values (62.44%) of WCE in comparison to rest of the treatments followed by (61.10%) Conventional Tillage (*kharif* and *rabi* season); while losable value (40.88%) was noticed under Zero Tillage *(kharif* and *rabi* season).

Significant reduction of weed parameters at different stages due to Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) was due to loosening of the soil more effectively than zero tillage practice, which might have facilitated percolation and storage of water in the root zone. The possible explanation for this could be that at early stage of the crop, the growth of weeds and crop as well was not vigorous therefore they do not had shading effect on weeds, whereas at later stages of crop growth; high crop cover deprived the weeds to photo synthetically active radiation. Results of present investigation are in close conformity with the findings of Amgain *et al.*[1], Choudhary *et al*.[3] and Verma *et al*.[12].

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) recorded significantly higher value of growth parameters viz. plant height (cm), dry matter/plant (g) in comparison to rest of the treatments followed by Conventional Tillage (*kharif* and *rabi* season); while lowest value was registered under Zero Tillage *(kharif* and *rabi* season).

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) recorded significantly higher value of yield attributes viz. girth of ear head, no. of seeds/ear head and test weight (2.355 mm, 1315.26 and 9.52 g; respectively) followed by (2.333 mm, 1308.18 and 9.46 g; respectively) Conventional Tillage (*kharif* and *rabi* season) in comparable to rest of the treatments; while lowest value (2.179 mm, 1235.48 and 8.94 g; respectively) was noticed under Zero Tillage *(kharif* and *rabi* season).

The Conventional Tillage (*Kharif* season) and Zero Tillage (*Rabi* season) recorded significantly maximum value of computed parameters viz. grain yield and stover yield (2305 kg/ha and 4255 kg/ha; respectively) followed by (2175 kg/ha and 4045 kg/ha; respectively) Conventional Tillage (*kharif* and *rabi* season) in comparable to rest of the treatments; while lowest value (1492 kg/ha and 3008 kg/ha; respectively) was noticed under Zero Tillage *(kharif* and *rabi* season).

This may be explained due to the fact that better tilled soil done efficient use of all available natural resources and effective absorption and utilization of nutrients and moisture resulted leading to higher photosynthetic rate and finally more accumulation of dry matter by the plants; this resulted heaviest grains. Our results confirm with the findings of Amgain *et al.*[1], Choudhary *et al*.[3] and Verma *et al*.[12].

❖ **Weed management practices (W)**

The total weed population was significantly higher under Weedy check (*kharif* and *rabi* season); while lowest was recorded under IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season.

The significantly inferior value (6.59%) of WCE was noted under Weedy check (*kharif* and *rabi* season); while superior (77.73%) was recorded under IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season.

The superiority of IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season over rest of the weed management practices may be due to their

broad-spectrum effect by combination of chemical and mechanical measures; which enhance weed management ability over rest of the treatments. The results are in conformity with the findings of Reddi Ramu[10], Guggari and Mallappa[4] and Singh *et al*.[11].

The growth parameters viz. plant height (cm) and dry matter/plant (g) were recorded significantly maximum under IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season; while lowest was recorded under Weedy check (*kharif* and *rabi* season).

IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season registered significantly higher value of yield attributes viz. girth of ear head, no. of seeds/ear head and test weight (2.380 mm, 1326.91 and 9.63 g; respectively); while lowest value (2.084 mm, 1191.50 and 8.61 g; respectively) was observed under Weedy check (*kharif* and *rabi* season).

IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *Kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *Rabi* season registered significantly higher value of computed parameters viz. grain yield and stover yield (2321 kg/ha and 4269 kg/ha; respectively); while lowest value (1188 kg/ha and 2531 kg/ha; respectively) was observed under Weedy check (*kharif* and *rabi* season).

Due to favourable conditions created by weed management practices; which resulted higher accumulation of crop dry matter and optimum translocation of food materials to the pod as well as effective uptake of nutrients and moisture. This might be due to effective control of weeds and thus resulted in lower accumulation of dry matter in weeds and lower crop-weed competition associated with effective availability of moisture and nutrients. These results are in line with the work of Guggari and Mallappa[4] and Singh *et al*.[11].

Response observed in Mustard:-

❖ **Tillage Practices (T)**

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) significantly reduced value of total weed population in comparison to rest of the treatments followed by Conventional Tillage (*kharif* and *rabi* season).

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) registered significantly effective values (62.33%) of WCE in comparison to rest of the treatments followed by (60.98%) Conventional Tillage (*kharif* and *rabi* season); while losable value (40.72%) was noticed under Zero Tillage *(kharif* and *rabi* season).

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) recorded significantly higher value of growth parameters viz. plant height (cm), number of branches/plant and dry matter/plant (g) in comparison to rest of the treatments followed by Conventional Tillage (*kharif* and *rabi* season); while lowest value was registered under Zero Tillage *(kharif* and *rabi* season).

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) recorded significantly higher value of yield attributes viz. number of siliqua/plant, number of seeds/siliqua and test weight (165.03, 11.61 and 3.58 g; respectively) followed by (164.00, 11.53 and 3.56 g; respectively) Conventional Tillage (*kharif* and *rabi* season) in comparable to rest of the treatments; while lowest value (154.17, 10.78 and 3.34 g; respectively) was noticed under Zero Tillage *(kharif* and *rabi* season).

The Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) recorded significantly maximum value of computed parameters viz. grain yield and stover yield (1156 kg/ha and 3068 kg/ha; respectively) followed by (1132 kg/ha and 3038 kg/ha; respectively) Conventional Tillage (*kharif* and *rabi* season) in comparable to rest of the treatments; while lowest value (929 kg/ha and 2654 kg/ha; respectively) was noticed under Zero Tillage *(kharif* and *rabi* season).

Results of present investigation are in close conformity with the findings of Jakhar *et al*.[6].

❖ **Weed management practices (W)**

The total weed population was significantly higher under Weedy check (*kharif* and *rabi* season); while lowest was recorded under IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season.

The significantly inferior value (6.61%) of WCE was noted under Weedy check (*kharif* and *rabi* season); while superior (77.53%) was recorded under IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season.

The results are in conformity with the findings of Yadav *et al*.[14] and Gupta *et al*.[5].

The growth parameters viz. plant height (cm), number of branches/plant and dry matter/plant (g) were recorded significantly maximum under IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season; while lowest was recorded under Weedy check (*kharif* and *rabi* season).

IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season registered significantly higher value of yield attributes viz. number of siliqua/plant, number of seeds/siliqua and test weight (167.06, 11.77 and 3.62 g; respectively); while lowest value (148.11, 10.30 and 3.21 g; respectively) was observed under Weedy check (*kharif* and *rabi* season).

IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season registered significantly higher value of computed parameters viz. grain yield and stover yield (1190 kg/ha and 3160 kg/ha; respectively); while lowest value (819 kg/ha and 2385 kg/ha; respectively) was observed under Weedy check (*kharif* and *rabi* season).

Could be ascribed to effective weed suppression during critical period of crop weed competition which might have favoured better utilization of available resources. Similar findings have also been reported by Yadav *et al*.[14] and Gupta *et al*.[5].

Table 1: Effect of tillage practices and weed management practices on total weed population (/m^2), growth & yield attributing parameters and yield of Pearl Millet

Treatment	Total weed population (/m^2)	Weed Control Efficiency (%)	Plant height (cm)	Dry matter/plant (g)	Girth of Ear head (mm)	No. of seeds/ear head	Test weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)
Tillage practices									
T_1	1.507 (49.04)	61.10	144.08	107.48	2.333	1308.18	9.46	2175	4045
T_2	1.472 (47.35)	62.44	145.00	110.22	2.355	1315.26	9.52	2305	4255
T_3	1.825 (74.52)	40.88	135.52	88.56	2.179	1235.48	8.94	1492	3008
T_4	1.797 (71.13)	43.59	137.37	94.33	2.209	1252.22	9.06	1600	3182
T_5	1.732 (65.32)	48.17	139.04	98.17	2.247	1265.91	9.17	1781	3469
SE(m) ±	**0.005**	**0.39**	**0.09**	**0.65**	**0.005**	**2.20**	**0.01**	**46**	**41**
CD (P=0.05)	**0.014**	**1.16**	**0.28**	**1.90**	**0.013**	**6.49**	**0.03**	**135**	**120**
Weed management practices									
W_1	1.569 (38.57)	69.39	143.62	105.33	2.330	1304.82	9.45	2103	3975
W_2	1.361 (28.08)	77.73	146.83	112.21	2.380	1329.91	9.63	2321	4269
W_3	2.070 (117.77)	6.59	130.14	81.71	2.084	1191.50	8.61	1188	2531
SE(m) ±	**0.001**	**0.03**	**0.07**	**0.06**	**0.004**	**0.68**	**0.01**	**41**	**63**
CD (P=0.05)	**0.004**	**0.08**	**0.21**	**0.19**	**0.012**	**2.13**	**0.03**	**128**	**199**
Transformation	**Log(x)**	-	-	-	-	-	-	-	-

Table 2: Effect of tillage practices and weed management practices on total weed population (/m^2), growth & yield attributing parameters and yield of Mustard

Treatment	Total weed population (/m^2)	Weed Control Efficiency (%)	Plant height (cm)	Number of branches/plant	Dry matter/plant (g)	No. of Siliqua/plant	No. of Seeds/siliqua	Test weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)
Tillage practices										
T_1	1.288 (29.35)	60.98	145.28	11.65	14.40	164.00	11.53	3.56	1132	3038
T_2	1.253 (28.33)	62.33	146.19	11.73	14.77	165.03	11.61	3.58	1156	3068
T_3	1.603 (44.59)	40.72	136.57	10.89	11.87	154.17	10.78	3.34	929	2654
T_4	1.573 (42.48)	43.52	138.41	11.06	12.64	156.24	10.95	3.38	971	2710
T_5	1.510 (39.07)	48.05	140.13	11.22	13.16	158.19	11.11	3.43	1012	2793
SE(m) ±	**0.0036**	**0.41**	**0.11**	**0.02**	**0.09**	**0.13**	**0.02**	**0.007**	**4**	**10**
CD (P=0.05)	**0.0107**	**1.20**	**0.32**	**0.07**	**0.26**	**0.39**	**0.07**	**0.020**	**11**	**31**
Weed management practices										
W_1	1.348 (23.16)	69.22	144.74	11.63	14.12	163.40	11.51	3.54	1112	3013
W_2	1.143 (16.90)	77.53	148.02	11.89	15.04	167.06	11.77	3.62	1190	3160
W_3	1.846 (70.24)	6.61	131.18	10.40	10.95	148.11	10.30	3.21	819	2385
SE(m) ±	**0.0004**	**0.04**	**0.07**	**0.02**	**0.01**	**0.10**	**0.02**	**0.005**	**4**	**10**
CD (P=0.05)	**0.0013**	**0.13**	**0.21**	**0.05**	**0.03**	**0.31**	**0.05**	**0.014**	**13**	**30**
Transformation	**Log(x)**	-	-	-	-	-	-	-	-	-

CONCLUSION

Conventional Tillage (*kharif* season) and Zero Tillage (*rabi* season) (T_1) and IWM (Atrazin @ 0.5 kg ai/ha PE + 1 HW at 25 DAS) *kharif* and (Pendimethalin @ 1.0 kg ai/ha + 1 HW at 25 DAS) in *rabi* season (W_5) as well as their interaction noticed significantly superior values of weed parameters and crop growth & yield parameters of pearl millet – mustard cropping system over rest of the treatments.

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