

## Comparison of straw mulching and herbicide levels for control of various weed species in maize (*Zea mays* L.)

### ABSTRACT

Weed management in maize is one of the biggest concerns for growers. To reduce dependence on chemicals and chances of herbicide resistant weeds, and to improve soil status, thus straw mulching was added as cultural component with chemicals for improving weed management in maize. Field experiments were conducted at two locations (Punjab Agricultural University, Ludhiana, and Regional Research Station, Gurdaspur) during kharif season to find out the influence of different paddy straw mulch and herbicides for control of various weed species in maize. The results showed that application of paddy straw mulch 6.25 t/ha effectively controlled *Eleusine indica*, *Cynodon dactylon*, *Commelinabenghalensis*, *Eragrostis tenella*, *Digitaria sanguinalis*, *Echinochloa colona*, *Trianthem portulacastrum*, *Portulaca oleracea*, *Phyllanthus niruri*, *Euphorbia hirta*, *Conyza stricta* and *Cyperus compressus* over no mulching. In addition to above weed species, paddy straw mulch 9.0 t/ha also effectively reduced density of *Dactyloctenium aegyptium*, *Acrachnera racemosa*, *Digera arvensis*, *Mollugo nudicaulis*, *Alternanthera philoxeroides*, *Amaranthus viridis* and *Veronica agrestis* and *Cyperus rotundus* as compared to 6.25 t/ha and no mulch treatment. Pre emergence application of atrazine at 1.0 kg/ha helped to manage *Eleusine indica*, *Echinochloa crusgalli*, *Eragrostis tenella*, *Digitaria sanguinalis*, *Echinochloa colona*, *Trianthem portulacastrum*, *Mollugo nudicaulis*, *Alternanthera philoxeroides*, *Digera arvensis*, *Amaranthus viridis* and *Cyperus compressus* in comparison to atrazine at 0.8 kg/ha and unweeded control at all stages. Post emergence application of tembotrione reduced the density of all weed species compared to atrazine and unweeded control.

**Keywords:** Atrazine, maize, straw mulching, tembotrione, weed species.

### INTRODUCTION

Maize being a C<sub>4</sub> plant is one of the most important cereal crop grown under diverse soil and climatic conditions. In India, maize-wheat is a major cropping system adopted on a large scale in Indo-gangetic plains of the country. The low productivity in maize may be due to many limiting factors of which poor weed management poses severe threat to crop productivity. Weeds are the plants which do more harm than benefits. Weeds are the undesirable plants which affect the crop production both in quality and quantity and also cause reduction in effective resource utilization by crop plants. Weed control is a major challenge in maize production as weeds can curtail grain yield by 86% (Bijan-zadeh and Hossein 2006). Globally, weed caused 10 per cent losses in agricultural production due to their competitive effect even regular control of weeds in most agricultural systems (Zimdahl 2004). World wide maize production is hampered up to 40 percent by competition from weeds (Oerke and Dehne 2004). Unchecked weed growth in maize causes yield losses even up to 100% (Sharma 2005). Severe infestation due to wider row spacing inflicts huge losses in yield, may be up to 52 per cent in maize (Walia *et al* 2005). The extent of losses due to weeds, however, depends upon different weed species associated with crop (Hirwe *et al* 2023). The

predominant weed species associated in maize are *Dactyloctenium aegyptium*, *Eleusine indica*, *Cynodon dactylon*, *Echinochloa colona*, *Brachiaria reptans*, *Digitaria sanguinalis*, *Sorghum halepense*, *Panicum* spp., *Digitaria ciliaris*, *Leptochloa chinensis* and *Commelinabenghalensis* as grasses, *Ageratum conyzoides*, *Oxalis latifolia*, *Celosia argentea*, *Cleome viscosa*, *Sida acuta*, *Portulacaoleracea*, *Phyllanthus niruri*, *Amaranthus viridis*, *Tridax procumbens*, *Ipomoea pestigridis*, *Parthenium hysterophorus* and *Euphorbia hirta* as broadleaf weeds and *Cyperus rotundus* as sedges. These weed species vary with location, climatic conditions, cultural practices, crop rotation, soil management, weed control measures and inherent weed seed bank in the soil (Hargilas 2020, Nayak et al 2022, Singh et al 2022). Weed plants are blessed with many growth characteristics and adaptations which enable them to exploit successfully numerous ecological niches. Certain weeds by virtue of favorable adaptations like synchronized germination, shading effects by the crop at the time of establishment, quick response to available soil moisture and nutrients, adaptation to adverse soil and climatic conditions, herbicide resistance, morphological similarity and ready contamination with crop seeds make them associated with the specific crops. Weed flora changes with respect to location viz. *Cyperus rotundus* and *Trianthem portulacastrum* were dominant weed species in spring maize at Hisar whereas at Orissa, *Cynodon dactylon*, *Digitaria sanguinalis*, *Digitaria ciliaris*, *Leptochloa chinensis*, *Dactyloctenium aegyptium*, *Eleusine indica*, *Cyperus rotundus*, *Cyperus iria*, *Celosia argentea*, *Commelinabenghalensis*, *Sida acuta* and *Aschynomene indica* were found dominant in rainfed maize. *Cyperus rotundus* as sedges was the most dominant weed in maize fields at Almora, Uttaranchal (Pandey et al 2001).

Due to diverse weed flora, weeds have become a major constraint in maize. The yield losses in maize due to weeds vary from location to location owing to differences in management practices, climate and other factors. The success of maize crop depends upon the weed control by using herbicides. However, herbicides should not be considered as replacement for other weed control measures but can be used in combination with these measures. The use of mulch has shown promising results for reducing weed pressure in maize (Bhatt and Khera 2006, Sarkar and Singh 2007, Anikwe et al 2007, Glab and Kulig 2008). Straw mulching in combination with weed control by using herbicides has the potential to manage diverse weed population. The combination of chemical and non-chemical approaches i.e. mulch will help in better control of weeds than use of any single approach in maize. This information is lacking in literature, so the present study was undertaken to gather information of controlling various weed species in maize with different straw mulch and herbicide levels.

## MATERIALS AND METHODS

Field studies were conducted at two locations during *kharif* season of 2017 as multilocation trial at Research Farm of Punjab Agricultural University, Ludhiana, Punjab, India and Research Farm of Regional Research Station, Gurdaspur, Punjab, India. Soil at Ludhiana site had a pH of 7.5, 81.50 % sand, 10.80 % silt and 7.70 % clay with available N, P and K of 138.1, 17.2 and 179.1 kg/ha, respectively whereas at Gurdaspur site, the soil had a pH of 7.4, 61.11 % sand, 12.98 % silt and 25.91 % clay with available N, P and K of 136.6, 18.9 and 195.3 kg/ha, respectively. The study comprised of three straw mulch treatments: no mulch (NM),

paddy straw mulch at 6.25 t/ha (PSM 6.25 t/ha), paddy straw mulch at 9.0 t/ha (PSM 9.0 t/ha) and six weed control treatments: atrazine at 1.0 kg/ha pre-emergence, atrazine at 0.8 kg/ha pre-emergence, tembotrione at 0.110 kg/ha at 20 DAS, tembotrione at 0.088 kg/ha at 20 DAS, weed free and unweeded check. The experiment was laid out in a factorial randomized block design with three replications at both locations. Maize (hybrid PMH1) was sown on 22 June, 2017 at Ludhiana whereas at Gurdaspur it was sown on 6<sup>th</sup> June, 2017 using seed rate of 20 kg/ha. Paddy straw mulch (PSM) was applied immediately after the emergence of maize seedlings in between the lines as per the treatments. For controlling the weeds, herbicides Atrataf 50WP (atrazine) as pre-emergence (within 2 days of sowing) and Laudis 420SC (tembotrione) with activator at 1000 ml/ha as post-emergence (at 20 DAS) were applied as pre-treatments. The herbicides were applied using knapsack sprayer that delivered 500 l/ha spray solution for PRE herbicide through flood jet nozzle and 375 l/ha for POST herbicide through a flat fan nozzle. The efficacy of various straw mulch and herbicide levels was evaluated at 20 DAS and at harvest. Two quadrates of 50 cm × 50 cm were randomly placed in each plot during each sampling time to determine the density of different weed species. Weed count was recorded species-wise and expressed in number per square meter. Data were analyzed using GLM procedure in SAS 9.3 to evaluate differences between treatments. The treatments means were made at P ≤ 0.05 by using Duncan's Multiple Range Test (DMRT). Weed density was square root transformed ( $\sqrt{x+1}$ ) before performing ANOVA because of high variance. The square root transformed and original values are presented for clear presentation of weed data.

## RESULTS AND DISCUSSION

### Species-wise weed density at 20 days after sowing:

The data on species wise density of different weeds were recorded at 20 days after sowing (DAS) at both the locations and are represented in table 1 and 2. The study showed that at 20 DAS, major weed species observed at Ludhiana site were *Dactyloctenium aegyptium*, *Eleusine indica* and *Commelinabenghalensis* among grasses, *Trianthem portulacastrum*, *Portulaca oleracea* and *Digera arvensis* among broadleaf weeds and *Cyperus rotundus* and *Cyperus compressus* were recorded as sedges whereas, at Gurdaspur, *Dactyloctenium aegyptium* and *Cynodon dactylon* as grasses, *Trianthem portulacastrum*, *Digera arvensis*, *Alternanthera philoxeroides* and *Amaranthus viridis* were among broadleaf weeds and only *Cyperus rotundus* was recorded as sedge. *Eleusine indica*, *Commelinabenghalensis* and *Euphorbia hirta* were also present at lower densities at Gurdaspur. Diversity in weed flora at different locations was also observed by Ndam *et al* (2014). Pandey *et al* (2001) reported that *Cyperus rotundus* was the most dominant weed among sedges in maize fields.

It was observed that application of 9.0 t/ha mulch resulted in minimum density of *D. aegyptium*, *C. benghalensis*, *D. arvensis*, *C. rotundus* and *C. compressus* at Ludhiana and *D. aegyptium*, *D. arvensis*, *A. philoxeroides*, *A. viridis* and *C. rotundus* at Gurdaspur as compared to 6.25 t/ha and no mulch treatments. Similarly, application of both 6.25 t/ha and 9.0 t/ha mulch recorded statistically similar and significantly lower density of *E. indica*, *T. portulacastrum* and *P. oleracea* at Ludhiana and *C. dactylon* and *T. portulacastrum* at Gurdaspur as compared to

nomulching.

Among weed control treatments, minimum density of all weeds was recorded under weed free treatment whereas maximum density was observed under unweeded check. From the herbicides, atrazine 1.0 kg/ha resulted in significantly less density of *D. aegyptium*, *C. benghalensis*, *C. rotundus* and *C. compressus* at Ludhiana and *D. aegyptium*, *D. arvensis*, *A. philoxeroides* and *C. rotundus* at Gurdaspur in comparison to its lower dose, but the later one also significantly controlled the density of *D. aegyptium*, *D. arvensis* and *C. compressus* at Ludhiana and *D. aegyptium* and *D. arvensis* at Gurdaspur as compared to unweeded check. However, the density of *C. dactylon* at Gurdaspur was not significantly influenced by both doses of atrazine. The higher weed population was observed in both tembotrione treatments at 20 DAS because this herbicide was applied as post emergence after collection of weed data at 20 DAS. Thus the data showed that initial flush of *D. aegyptium*, *C. benghalensis*, *A. philoxeroides*, *C. rotundus* and *C. compressus* were controlled with the application of atrazine at 1.0 kg/ha within 2 days of sowing, whereas atrazine at 0.8 kg/ha applied within 2 days of sowing effectively controlled *E. indica*, *T. portulacastrum*, *A. viridis*, *P. oleracea* and *D. arvensis*. Chopra and Angiras (2008) also corroborated with the research findings on Atrazine as pre-emergence application.

#### Species-wise weed density at harvest:

Species-wise density of different weeds at harvest was recorded at Ludhiana and Gurdaspur represented in table 3 and 4. The major weed species observed at harvest at Ludhiana were *D. aegyptium*, *E. indica*, *C. benghalensis*, *E. tenella*, *D. sanguinalis* and *E. colona* among grasses, *D. arvensis* as broadleaf weed and *C. rotundus* and *C. compressus* were recorded as sedges whereas at Gurdaspur, *D. aegyptium*, *E. indica*, *C. dactylon* and *E. tenella* were the major grass weed species, *E. hirta*, *A. viridis*, *V. agrestis* and *C. stricta* were among broadleaf weeds and only *C. rotundus* was recorded as sedges.

Application of 9.0 t/ha mulch resulted in significantly less density of *D. aegyptium*, *C. benghalensis*, *E. tenella*, *D. sanguinalis*, *D. arvensis* and *C. rotundus* as compared to 6.25 t/ha and no mulch treatments at Ludhiana. However, both 6.25 and 9.0 t/ha mulch treatments recorded statistically similar and significantly lower density of *E. indica*, *E. colona* and *C. compressus* as compared to no mulch treatment. On the other hand at Gurdaspur, application of 9.0 t/ha mulch resulted in minimum density of *D. aegyptium*, *C. dactylon*, *A. viridis*, *V. agrestis* and *C. rotundus* as compared to 6.25 t/ha and no mulch treatments. Similarly, both 6.25 t/ha and 9.0 t/ha mulch treatments were statistically similar and significantly better in controlling the density of *E. indica*, *E. tenella*, *E. hirta* and *C. stricta* as compared to no mulch treatment. Kumar and Angadi (2014) reported that mulch is a good agronomic manipulation for weed management in maize. Uwah and Iwo (2011) also observed that straw mulch recorded significantly less weed density in comparison to no mulch.

In case of herbicide treatments, application of tembotrione at both doses (0.088 and 0.110 kg/ha) resulted in significantly better control of *D. aegyptium*, *C. benghalensis*, *E. tenella*, *D. arvensis* and *C. rotundus* at Ludhiana and *D. aegyptium*, *E. hirta*, *V. agrestis*, *C. stricta* and *C. rotundus* at Gurdaspur in comparison to atrazine at both doses (0.8 and 1.0 kg/ha) and unweeded check. Whereas, application of tembotrione at both doses and atrazine at 1.0 kg/ha were statistically similar in reducing the

density of *E. indica*, *E. tenella*, *D. sanguinalis*, *E. colona* and *C. compressus* at Ludhiana and *E. indica*, *C. dactylon*, *E. tenella* and *A. viridis* at Gurdaspur but were significantly better as compared to the atrazine at 0.8 kg/ha and unweeded check. Atrazine at both doses also recorded significantly better control of all the weed species as compared to unweeded check except *C. stricta* which was re-emerged and not controlled at harvest. Thus, the results indicated that tembotrione at 0.088 and 0.110 kg/ha were more effective in controlling different weed species in maize followed by atrazine at 1.0 kg/ha and atrazine at 0.8 kg/ha. Rana *et al* (2017) also observed that post emergence application of tembotrione effectively controlled the population of *Echinochloa colona*, *Commelinabenghalensis*, *Polygonum alatum* and *Ageratum conyzoides*.

#### Conclusion

It is concluded that application of paddy straw mulch 6.25 t/ha effectively controlled *E. indica*, *C. dactylon*, *C. benghalensis*, *E. tenella*, *D. sanguinalis*, *E. colona*, *T. portulacastrum*, *P. oleracea*, *P. niruri*, *E. hirta*, *C. stricta* and *C. compressus* over no mulching. In addition to above species, paddy straw mulch 9.0 t/ha also effectively reduced density of *D. aegyptium*, *A. racemosa*, *D. arvensis*, *M. nudicaulis*, *A. philoxeroides*, *A. viridis* and *V. agrestis* and *C. rotundus* as compared to 6.25 t/ha and no mulch treatments. Post emergence application of tembotrione at 0.088 and 0.110 kg/ha significantly reduced the density of all weed species observed in research experiments in comparison to atrazine at 0.8 and 1.0 kg/ha and unweeded check.

#### REFERENCES

- Anikwe MAN, Mbah CN, Ezeaku PI and Onyia VN. 2007. Tillage and plastic mulch effects on soil properties and growth and yield of cocoyam (*Colocasia esculenta*) on an ultisol in southeastern Nigeria. *Soil and Tillage Research* **93**:264-273.
- Bhatt R, and Khera KL. 2006. Effect of tillage and mode of straw mulch application on soil erosion in submontaneoustract of Punjab, India. *Soil and Tillage Research* **88**: 107-115.
- Bijanzadeh E and Hossein G. 2006. Effect of separate and combined treatments of herbicides on weed control and maize (*Zea mays* L.) yield. *Weed Technology* **20**:640-645.
- Chopra P and Angiras NN. 2008. Influence of tillage and weed control methods on weeds, yield and yield attributes of maize (*Zea mays* L.). *Indian Journal of Weed Science* **40**:47-50.
- Glab T and Kulig B. 2008. Effect of mulch and tillage system on soil porosity under wheat (*Triticum aestivum*). *Soil and Tillage Research* **99**: 169-178.
- Hargilas H. 2020. Effective weed management strategy for maize (*Zea mays*) under rainfed conditions of southern Rajasthan. *Indian Journal of Agricultural Sciences* **90**:693-698.
- Hirwe O, Kumar S, Sri K, Reddy P, Kumar N, Nandana S, Sharma S and Bhat S. 2023. Different weed management techniques in maize (*Zea mays* L.): A Review. *International Journal of Plant and Soil Science* **35**:179-191.
- Kumar BRM and Angadi SS. 2014. Effect of tillage, mulch and weed management on performance of maize (*Zea mays*) in Karnataka. *Indian Journal of Dryland Agriculture Research and Development* **29**: 57-62.
- Nayak A, Khanda CM, Das S, Mohanty SK, Sahoo BB and Nayak BS. 2022. Enhancing hybrid maize (*Zea mays*) productivity, profitability and energetics through tillage and weed-management practices in Eastern India. *Indian Journal of Agronomy* **67**:152-157.
- Ndam LM, Enang JE, Mih AM, and Egbe AE. 2014. Weed diversity in maize (*Zea mays* L.) fields in South Western Cameroon. *International Journal of Current Microbiology*

- and *Applied Sciences* **3**:173-180.
- Oerke, EC and Dehne HW. 2004. Safeguarding production losses in major crops and role of crop production. *Crop Protection* **23**: 275-285.
- Pandey AK, Parkash V, Singh RD and Mani VP. 2001. Integrated weed management in maize (*Zea mays*). *Indian Journal of Agronomy* **46**: 260-265.
- Rana SS, Badiyala D, Sharma N, Kumar R and Pathania P. 2017. Impact of tembotrione on weed growth, yield and economics of maize (*Zea mays* L.) under Mid Hill conditions of Himachal Pradesh. *Pesticide Research Journal* **29**: 27-34.
- Sarkar S and Singh SR. 2007. Interactive effect of tillage depth and mulch on soil temperature, productivity and water use pattern of rainfed barley (*Hordium vulgare* L.). *Soil and Tillage Research* **92**: 79-86.
- SAS User's Guide. SAS Institute, Cary, NC (USA).
- Sharma R. 2005. Integrated weed management in kharif maize. *Intensive Agriculture*, May-June: 6-9.
- Singh VP, Paliwal A, Pratap T, Singh SP, Kumar A and Shyam R. 2022. Bio-efficacy of nicosulfuron against mixed weed flora in maize and its residual effect on succeeding crops. *Indian Journal of Weed Science* **54**: 251-256.
- Uwah DF and Iwo GA. 2011. Effectiveness of organic mulch on the productivity of maize (*Zea mays* L.) and weed growth. *Journal of Animal and Plant Sciences* **21**: 525-530.
- Walia US, Brar LS and Singh B. 2005. *Recommendations for weed control in field crops*. Research Bulletin, Department of Agronomy, Agrometeorology and Forestry, PAU Ludhiana. Pp. 5.
- Zimdahl RL. 2004. *Weed crop competition: A review*. Pp 109-130 Oxford, UK, Blackwell Publishers.

**Table1. Species-wise weed density (number m<sup>-2</sup>) as influenced by straw mulching and herbicides at20DAS in maize in field experiments conducted at Ludhiana, Punjab**

Treatment	Grasses			BLWs*			Sedges	
	<i>D.aegyptium</i>	<i>E. indica</i>	<i>C. benghalensis</i>	<i>T. portulacastrum</i>	<i>P. oleracea</i>	<i>D. arvensis</i>	<i>C. rotundus</i>	<i>C. compressus</i>
<i>Strawmulch</i>								
Nomulch	12.05 (185)c	3.57 (18)b	2.83 (8)c	2.02 (4)b	1.50 (2)b	2.96 (9)c	4.66 (24)c	11.51 (167)c
PSM6.25 t/ha	4.50 (26)b	1.00(0 )a	2.08 (4)b	1.00 (0)a	1.00 (0)a	2.05 (4)b	3.90 (18)b	5.86 (46)b
PSM9.0 t/ha	3.29 (13)a	1.00(0 )a	1.54 (2)a	1.00 (0)a	1.00 (0)a	1.69 (2)a	3.54 (15)a	4.34 (25)a
<i>Weedcontrol</i>								
Atrazineat1.0k g/ha	3.11 (18)b	1.00(0 )a	1.66 (3)b	1.00 (0)a	1.00 (0)a	1.41 (1)b	1.86 (4)b	2.93 (15)b
Atrazineat0.8k g/ha	6.64 (53)c	1.14( 0.4)a	2.32 (5)c	1.00 (0)a	1.00 (0)a	1.99 (4)b	5.30 (28)c	7.32 (64)c
Tembotrioneat 0.110 kg/ha	9.66( 126)d	2.66 (12)b	2.50 (6)cd	1.75 (3)b	1.30 (1)b	2.99 (8)c	5.19 (26)c	10.83 (134)d
Tembotrioneat 0.088 kg/ha	9.64( 125)d	2.68 (12)b	2.68 (7)cd	1.66 (2)b	1.41 (1)b	2.98 (8)c	5.40 (29)c	10.69 (131)d
Weedfree	1.00 (0)a	1.00(0 )a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a
Unweeded check	9.64( 126)d	2.66 (12)b	2.75 (7)cd	1.67 (3)b	1.29 (1)b	3.03 (9)c	5.44 (29)c	10.64 (131)d

- Data were subjected to square root transformation  $\sqrt{x+1}$ . Original values are in parentheses.
- In a column, means followed by same letters do not vary significantly at 5% level by DMRT
- BLWs\*; Broad Leaf Weeds, DAS; Days after sowing, PSM; Paddy straw mulch

**Table 2. Species-wise weed density (number m<sup>-2</sup>) as influenced by straw mulching and herbicides at 20 DAS in maize in field experiments conducted at Gurdaspur, Punjab**

Treatment	Grasses		BLWs				Sedges
	<i>D. aegyptium</i>	<i>C. dactylon</i>	<i>T. portulacastrum</i>	<i>D. arvensis</i>	<i>A. philoxeroides</i>	<i>A. viridis</i>	<i>C. rotundus</i>
<i>Strawmulch</i>							
Nomulch	3.49(15)c	2.26(5)b	1.96(4)b	1.72(2)c	2.35(5)c	1.92(4)c	13.40(212)c
PSM6.25 t/ha	2.64(8)b	1.53(2)a	1.22(0.6)a	1.42(1)b	1.17(0.4)b	1.55(2)b	10.13(120)b
PSM9.0 t/ha	1.85(3)a	1.43(1)a	1.17(0.4)a	1.17(0.4)a	1.00(0)a	1.31(1)a	9.18(99)a
<i>Weedcontrol</i>							
Atrazineat1.0 kg/ha	1.72(3)b	1.71(3)a	1.00(0)a	1.00(0)a	1.20(0.6)b	1.00(0)a	10.62(116)b
Atrazineat0.8 kg/ha	1.91(4)c	2.13(4)a	1.00(0)a	1.17(0.4)b	1.58(2)c	1.00(0)a	13.77(191)c
Tembotrioneat 0.110 kg/ha	3.86(16)d	2.16(4)a	2.03(3.5)b	1.88(3)c	1.83(3)d	2.17(4)b	14.02(201)d
Tembotrioneat 0.088 kg/ha	4.02(18)d	2.18(4)a	2.02(3.4)b	1.89(3)c	1.84(3)d	2.10(3)b	13.98(200)d
Weedfree	1.00(0)a	1.00(0)a	1.00(0)a	1.00(0)a	1.00(0)a	1.00(0)a	1.00(0)a
Unweeded check	3.85(15)d	2.17(4)a	2.01(3.4)b	1.93(3)c	1.84(3)d	2.27(4)b	14.06(201)d

- Data were subjected to square root transformation  $\sqrt{x+1}$ . Original values are in parentheses.
- In a column, means followed by same letters do not vary significantly at 5% level by DMRT
- BLWs\*; Broad Leaf Weeds, DAS; Days after sowing, PSM; Paddy straw mulch

**Table 3. Species-wise weed density (number m<sup>-2</sup>) as influenced by straw mulching and herbicides at harvest in maize in field experiments conducted at Ludhiana, Punjab**

Treatment	Grasses						BLWs*	Sedges	
	<i>D.aegyptium</i>	<i>E. indica</i>	<i>C. benghalensis</i>	<i>E.tenella</i>	<i>D. sanguinalis</i>	<i>E.colona</i>	<i>D. arvensis</i>	<i>C. rotundus</i>	<i>C. compressus</i>
<i>Strawmulch</i>									
Nomulch	2.60 (8)c	1.24( 0.7)b	2.88 (9)c	2.20 (5)c	1.40 (2)c	1.25( 0.9)b	1.46 (1)c	3.04 (11)c	1.33 (1)b
PSM6.25 t/ha	2.18 (5)b	1.08( 0.2)a	2.39 (5)b	1.65 (2)b	1.09( 0.2)b	1.00 (0)a	1.24( 0.6)b	2.16 (5)b	1.00 (0)a
PSM9.0 t/ha	1.81 (3)a	1.00 (0)a	1.90 (3)a	1.40 (1)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.76 (3)a	1.00 (0)a
<i>Weedcontrol</i>									
Atrazineat1.0 kg/ha	2.64 (6)b	1.00 (0)a	2.53 (6)c	1.56 (2)a	1.00 (0)a	1.00 (0)a	1.23( 0.6)b	2.24 (4)c	1.00 (0)a
Atrazineat0.8 kg/ha	3.21 (10)c	1.73( 0.4)b	3.08 (9)d	2.16 (6)b	1.00 (0)a	1.00 (0)a	1.38 (1)c	2.97 (8)d	1.00 (0)a
Tembotrioneat 0.110 kg/ha	1.31( 0.9)a	1.00 (0)a	2.14 (4)b	1.27( 0.7)a	1.00 (0)a	1.00 (0)a	1.05( 0.1)a	1.77 (2)b	1.00 (0)a
Tembotrioneat 0.088 kg/ha	1.29( 0.9)a	1.00 (0)a	2.06 (4)b	1.27( 0.7)a	1.00 (0)a	1.00 (0)a	1.05( 0.1)a	1.65 (2)b	1.00 (0)a
Weedfree	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a
Unweeded check	3.74 (13)d	1.46 (1)c	3.53( 12)e	2.84 (8)c	1.98 (4)b	1.50 (2)b	1.70 (2)d	4.31 (20)e	1.67 (3)b

- Data were subjected to square root transformation  $\sqrt{x+1}$ . Original values are in parentheses.
- In a column, means followed by same letters do not vary significantly at 5% level by DMRT
- BLWs\*; Broad Leaf Weeds, DAS; Days after sowing, PSM; Paddy straw mulch

**Table4. Species-wise weed density (number m<sup>-2</sup>) as influenced by straw mulching and herbicides **atharvestin** maize in field experiments conducted at Gurdaspur, Punjab**

Treatment	Grasses				BLWs*				Sedges
	<i>D. aegyptium</i>	<i>E.indica</i>	<i>C. dactylon</i>	<i>E.tenella</i>	<i>E.hirta</i>	<i>A.viridis</i>	<i>V.agrestis</i>	<i>C.stricta</i>	<i>C. rotundus</i>
<i>Strawmulch</i>									
Nomulch	1.96 (3)c	1.66(2) )b	1.91 (3)c	1.99( 4)b	1.68 (2)b	1.38 (1)c	2.56 (7)c	1.69 (2)b	4.75 (26)c
PSM6.25 t/ha	1.81 (3)b	1.21( 0.6)a	1.55 (2)b	1.35( 1)a	1.38 (1)a	1.09( 0.2)b	1.89 (3)b	1.37 (1)a	4.13 (19)b
PSM9.0 t/ha Nomulch	1.27 (0.9)a	1.19 (0.6)a	1.27 (0.8)a	1.24 (0.8)a	1.30 (0.8)a	1.00 (0)a	1.45 (1)a	1.32 (0.9)a	3.34 (13)a
<i>Weedcontrol</i>									
Atrazineat 1.0 kg/ha	1.71 (2)c	1.25 (0.7)a	1.51 (2)b	1.22 (0.7)a	1.48 (1)b	1.00 (0)a	2.36 (5)b	1.61 (2)b	4.94 (24)c
Atrazineat 0.8 kg/ha	1.80 (3)c	1.40 (1.3)b	1.77 (2)c	1.86 (3)b	1.65 (2)b	1.17 (0.4)b	2.67 (7)b	1.97 (3)c	5.50 (30)d
Temboatrione at0.110 kg/ha	1.47 (1)b	1.17 (0.4)a	1.38 (1)b	1.17 (0.4)a	1.00 (0)a	1.00 (0)a	1.41 (1)a	1.00 (0)a	3.39 (11)b
Temboatrione at0.088 kg/ha	1.54 (1.6)b	1.17 (0.4)a	1.41 (1)b	1.22 (0.7)a	1.27 (0.7)a	1.00 (0)a	1.13 (0.4)a	1.00 (0)a	3.5 (11)b
Weedfree	1.00 (0)a	1.00(0) )a	1.00 (0)a	1.00( 0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a	1.00 (0)a
Unweeded check	2.56 (6)d	2.11(4 )c	2.38 (5)d	2.7( 8)c	2.32 (5)c	1.76 (3)c	3.22 (11)c	2.18 (4)c	6.27 (39)e

- Data were subjected to square root transformation  $\sqrt{x+1}$ . Original values are in parentheses.
- In a column, means followed by same letters do not vary significantly at 5% level by DMRT
- BLWs\*; Broad Leaf Weeds, DAS; Days after sowing, PSM; Paddy straw mulch