EVALUATION OF WHEAT AND WEED GROWTH UNDER DIFFERENT MULCHING AND ORGANIC AMENDMENTS

Kawsar Ali[1], Syed Ijaz ul Haq[2], Bushra[2], Palwasha Iqbal[1], Habib Ullah Khan[3], Sajid Ali[1], Asif Nawaz[1] and Hira Noor[1]

https://doi.org/10.28941/24-4(2018)-7

ABSTRACT

Weeds which seriously threaten wheat production are directly affected by cultural practices and nutrients management. Efficient weeds control in wheat will help to reduce problems associated with it. Different mulching materials were used during the course of the experiment with and without biochar. The experiment consisted of two factors such as Biochar (0 and 5 ton ha^{-1}) and mulching (Control, Plastics, paper and sorghum residues as mulch material) were used in the study. The experiment was conducted during winter 2017-18 at Abdul Wali Khan University research farm in Mardan, Pakistan. All treatments were laid out triplicate in randomized complete block design with a split plot arrangement. Biochar was allotted to main plots while mulching treatments were assigned to the sub plots. Wheat variety 'Siran 2007' was sown on 13th November, 2017. Results showed that different mulching material significantly affected weeds population, fresh and dry weight along with relative water content of weeds. Plastic and sorghum mulching performed better than paper mulching and no mulching. Weeds density was drastically reduced and wheat yield was positively improved in plastic and sorghum mulching compared to no mulching. Biochar significantly compressed weeds population and growth however, wheat yield and growth was also negatively affected by biochar application. Hence, plastic mulching is recommended for efficient weeds control and convincingly wheat yield improvement.

Keywords: Biochar, mulching, wheat, weeds, yield.

Citation: Ali, K., S. Ijaz ul Haq, Bushra, P. Iqbal, H. U. Khan, S. Ali, A. Nawaz and H. Noor. 2018. Evaluation of wheat and weed growth under different mulching and organic amendments. Pak. J. Weed Sci. Res. 24 (4):377-385.

[1] Department of Agriculture, Abdul Wali Khan University Mardan, Pakistan
[2] Center of Plant Biodiversity, University of Swat, Pakistan.
[3]Department of Agricultural Chemistry, The University of Agriculture, Peshawar, Pakistan.
Correspondence Author Email: kawsar@awkum.edu.pk

INTRODUCTION

Ensuring food security for the ever increasing population is one of the major challenge for agricultural scientist across the globe. Being staple food crop, wheat (Triticum aestivum L.) is declared as the leading crop to fulfill the food requirement of urban and rural community of the country (Ali et al., 2012; Ali et al., 2003). Although modern production technologies had played significant role to boost the wheat yield and per unit production however, lack of best management practices and adverse effect of these technologies on the environment encouraged many researchers to find alternative solution for controlling production constraints (Ali et al., 2011a). In Pakistan, wheat production ha-1 is much less than other advance countries. Weeds infestation and yield losses due to weeds is considered to be one of the most serious cause of poor wheat yield in Pakistan besides poor nutrients management practices and lack of high yielding varieties (Ali et al., 2011b; El-Bially et al., 1995; Hassan and Ahmad, 2005). Losses due to weeds ranges from 15% to 50 % in some cases or even more if not properly controlled. Weeds affect wheat crop in several ways; primarily as the best competitor for moisture, nutrients and space (Elliot et al., 1990; Farhad et al., 2009).

Generally, weed-infested wheat crop inflicts negative effect on yield and yield components of wheat. Fathi et al. (2003) and Gul et al. (2011) stated that weeds resulted in inhibitory effect on crops. Weeds competition with crops are quite complex in nature as weeds compete with the crop plants by occupying a space, which would otherwise be available to the crop plant as a result reducing the available space that leads to reduction in crop growth and establishment (Khaliq et al., 2004; Hussein, 19997). Weeds are also competing for soil moisture and creates water stress conditions for crop specially if sown on rainfed areas. Weeds water uptake is of great interest from the stand-point of competition with the crop plant for the available soil moisture (Khan et al., 1998). Oerke et al. (1996) and Shinde et al. (2001) stated that weeds infestation is one of the most important threats for the wheat crop production due to their higher and stronger competition for space, nutrients and moisture. Along with adverse effect on crop yields, weeds also reduce wheat grain quality. Several researchers such as Ali et al. (2012) and Khan et al. (1998) reported that canopy architecture of weeds especially plant height, location of branches and height of maximum leaf area determine the impact of competition for light and thus have a major influence on wheat yield and yield components.

Different methods can be used for weeds control such as mulching, tillage, planting geometry and sowing dates. All mulchings are believed to be one of the most effective control methods that not only control weeds population but also positively affect soil moisture holding capacity (Abouziena et al., 2008). Mulching is cultural weeds control strategy and it has pronounced effects on increasing water use efficiency (WUE) and wheat yield by significantly reducing weeds population per unit area. Different materials can be used for mulching practices. Plastic and wheat straw mulches was proven to increase water use efficiency by 79% and 58% respectively over no mulched plots (Arif et al., 2012). Based on a six years experiments on rice crop in China, Dada et al. (2010) found that weeds density m^{-2} was reduced by 70 - 80% in mulched plots and irrigation water use efficiency was increased by 274% when the crop was raised under the plastic film mulch conditions compared to the traditional planting.

Keeping in view the importance of weeds control methods and role of mulching in weeds control, the current experiment was designed to study the effect of different mulching materials on weeds and yield of wheat under the agro climatic conditions of district Mardan, Khyber Pakhtunkhwa.

MATERIALS AND METHODS

To evaluate the influence of various mulching materials on weeds and yield of wheat, an experiment was conducted at the research farm of Abdul Wali Khan University Mardan (AWKUM), Pakistan during 2015-2016. Before the execution of the experiment, soil of the experimental site was tested for various physico-chemical properties.

Collection of soil sample

Soil sample was randomly collected from the top layer of AWKUM research field (0 – 15 cm depth). Soon after collection, the soil was packed in gas permeable bags and was transferred to the research laboratory of the Department of Soil and Environmental Science, the University of Agriculture, Peshawar, Pakistan. Before various physico-chemical analyses, soil sample was sieved to let only 2mm sample passed through to remove plant residues, stones and earthworms. Data on the soil physico-chemical properties are presented in Table-1.

Table-1. Basic soil characteristics (physico-chemical properties) before the start of experiment.

Soil physical properties	Unit	Value (0-15cm depth)
Sand	%	29.21
Silt	%	64.20
Clay	%	7.21
Soil chemical properties		
pH	-	7.9
EC	D Sm^{-1}	0.47
Soil P	mg kg^{-1}	1.98
Sol total N	%	0.021
Sol K	mg kg^{-1}	74.25
Organic matter	%	0.53

Materials and design

The experiment was conducted in randomized complete block design with a split plot arrangement. The experiment comprised of three replications and five treatments. Wheat variety 'Siran-2007' was sown on 11th November 2015 with 100 kg ha^{-1} seed in rows. Six rows were adjusted in each experimental unit with row to row distance of 30 cm. The entire field was irrigated in the month of October to ensure proper moisture at the time of sowing. The field was ploughed two times followed by planking to level the field uniformly. Application of treatments (mulching) was exercised soon after emergence. The experiment consisted of six treatments such as newspaper mulching, wheat straw mulching, plastic mulching, stone mulching and hand weeding. A control treatment (no weeds control or weed check) was included for comparison. All mulching materials were spread among the rows in such a way that wheat seedlings were not covered by the concern material. Care was taken not to disturb the mulching cover while irrigating the field. Hand weeding was practiced three times before collecting the data i.e 40 days after sowing, 80 days after sowing and 120 days after sowing. Urea was used as source of nitrogen and DAP was used as source of phosphorus. Nitrogen was applied in three splits at the rate of 120 kg ha^{-1} while 100 kg ha^{-1} P was applied all at sowing. Field was irrigated two time as supplemental irrigation in the month of February and first week of April. Canal water was used as source of irrigation water.

Data recording

During the course of the experiment, data were recorded on weeds density m^{-2}, weeds fresh weight 50 days after sowing (DAS), weeds dry weight 50 days after sowing, weeds relative water content, tiller m^{-2}, plant height (cm), grain yield and biological yield (kg ha^{-1}) of wheat.

Statistical analysis

At the end of the experiment, the data were statistically analyzed using ANOVA and means were separated using LSD test at 5% level of probability (Steel & Torrie, 1984). Standard error of means were calculated and Sigma Plot (12.5) were used for creating graphs for comparing mean (Jan et al., 2009).

RESULTS AND DISCUSSION

Weeds related parameters

The influence of different mulching materials and organic amendments (biochar incorporation) on weeds density, fresh and dry weight and weeds relative water content is shown in Figure 1 (a-d). Overall, all treatment significantly affected weeds density (m^{-2}), fresh and dry weight and relative water content ($P< 0.05$). Figure 1(a) indicated that weeds density was lower in biochar treated plots compared to no biochar plots irrespective of mulching sources. As expected, weeds density was higher in control plots either treated with biochar or plots without biochar. Moreover, among mulching sources, the performance of plastic mulching were superior to sorghum and paper mulch in term of weeds controlling (Fig 1a). Weeds fresh weight was also significantly affected by biochar and mulching practices ($P < 0.05$). Overall, weeds fresh weight was higher in control plots irrespective of biochar. However, the effect of biochar on weeds fresh weight was not in linear manner as in under plastic and sorghum mulching, weeds fresh weight was lower in biochar treated plots while in contrast weeds fresh weight was lower in plots without biochar in paper mulched plots (Fig 1b). Furthermore, weeds dry weight was lower in biochar treated plots as compared to no biochar regardless of mulching sources (Fig 1c). Regarding mulching sources, weeds dry weight was lower in paper mulched plots followed by sorghum residues. Higher dry weight of weeds was recorded in weedy check plots (without mulching). Figure 1d indicated data regarding relative water content of weeds. The figure showed that relative water content was higher in control plots as compared to mulched plots. Lower relative water content was recorded in paper mulched plots followed by plastic mulching. Moreover, weeds relative water content was lower in biochar treated plots than no biochar plots.

Covering soil surface with mulch material can retard the growth of weeds due to failure of weeds germination as a result of no or less supply of oxygen (Menalled et al., 2005). Weeds seeds are photoblastic in nature and need specific amount of light for germination. Under mulching condition, such weeds fail to germinate as the soil surface is covered with mulching materials that may results in lower weeds density as noticed in our findings. Whalen et al. (2000) are of the view that biochar is rich source of carbon and may restrict seed germination if applied in alkaline soils. During the course of the study, results showed that weed density is lower in biochar treated plots compared to nonbiochar plots. Our results is in agreement with findings by Miyazawa et al. (2004). Weeds fresh weight is the consequences of weeds growth and development that directly depends on nutrients uptake. Fresh and dry weight of weeds was normally lower in mulched plots rather than control plots. The lower dry weight and fresh weight could be attributed to the poor growth of weeds in mulched plots as a result of poor root respiration and photosynthesis. Major et al. (2005) are of the view that weeds fresh and dry weight was lower in mulched plots irrespective of mulching sources.

Crop related parameters

Data were recorded on wheat growth and yield related parameters and are presented in figure 2 (a-d). Statistical data indicated that different mulching materials and biochar caused significant variation in wheat plant height, tillers m-2, biological and grain yield (kg ha-1) ($P < 0.05$). Taller plants were measured in all mulched plots as compared to control plots (plots without mulching materials) regardless of biochar application (Fig 2a). Among mulching materials, the performance of plastic mulching were superior than paper mulching however, it was at par with sorghum mulching. Overall, plant height was higher in no biochar treated plots compared to biochar treated plots in all mulched plots. However, biochar application in control plots improved plant height compared to non-biochar plots. Moreover, tillers m-2 were higher in plastic mulching which was at par with sorghum mulching followed by paper mulching (Fig 2b). Control plots resulted in less number of tillers m^{-2}.

The Figures 2c and 2d represent data regarding wheat biological and grain yield, respectively. Wheat biological and grain yield are economically the most important parameters and are greatly affected by weeds infestation. The figures indicated that higher biological and grain yield were produced in plots treated with different mulching materials than control plots. Overall, plastic and sorghum mulch resulted in higher biological and grain yield compared to paper mulched plots (Fig 2c & d). Application of biochar also resulted in lower wheat grain and biological yield irrespective of mulching sources. Covering soil with mulching materials can affect soil moisture conservation and water use efficiency that ultimately enhanced wheat yield and production (Ali et al., 2012). Plastic mulching is regarded as one of the best ways of improving water retention in the soil and reducing soil evaporation (Steiner, 1989, Li and Xiao, 1992, Baumhardt and Jones, 2002). It also proved to be an effective approach for sustainable wheat production in upland ecosystems, both in short-term experiments (Huang et al., 2005, Zhang et al., 2011) and a long-term simulation study (Zhang et al., 2015). Soil management regimes could change the characteristics of the soil surface, and hence influence the soil thermal properties that directly affect crop growth and development especially for winter crops. Several investigators have reported that the soil thermal regime under mulching is different from that of bare soil, with soil temperatures often being lower under mulched surfaces than in non-mulched soils (Bristow, 1988, Sarkar et al., 2007).

CONCLUSIONS

On the basis of our findings, the following conclusions are made:

i. Mulching can be used as a tool for weeds management and soil conservation.
ii. Plastic mulching is much better than paper mulch.
iii. Application of organic matter with high C:N ratio should be applied before sowing to prevent immobilization during active growth period of crop.

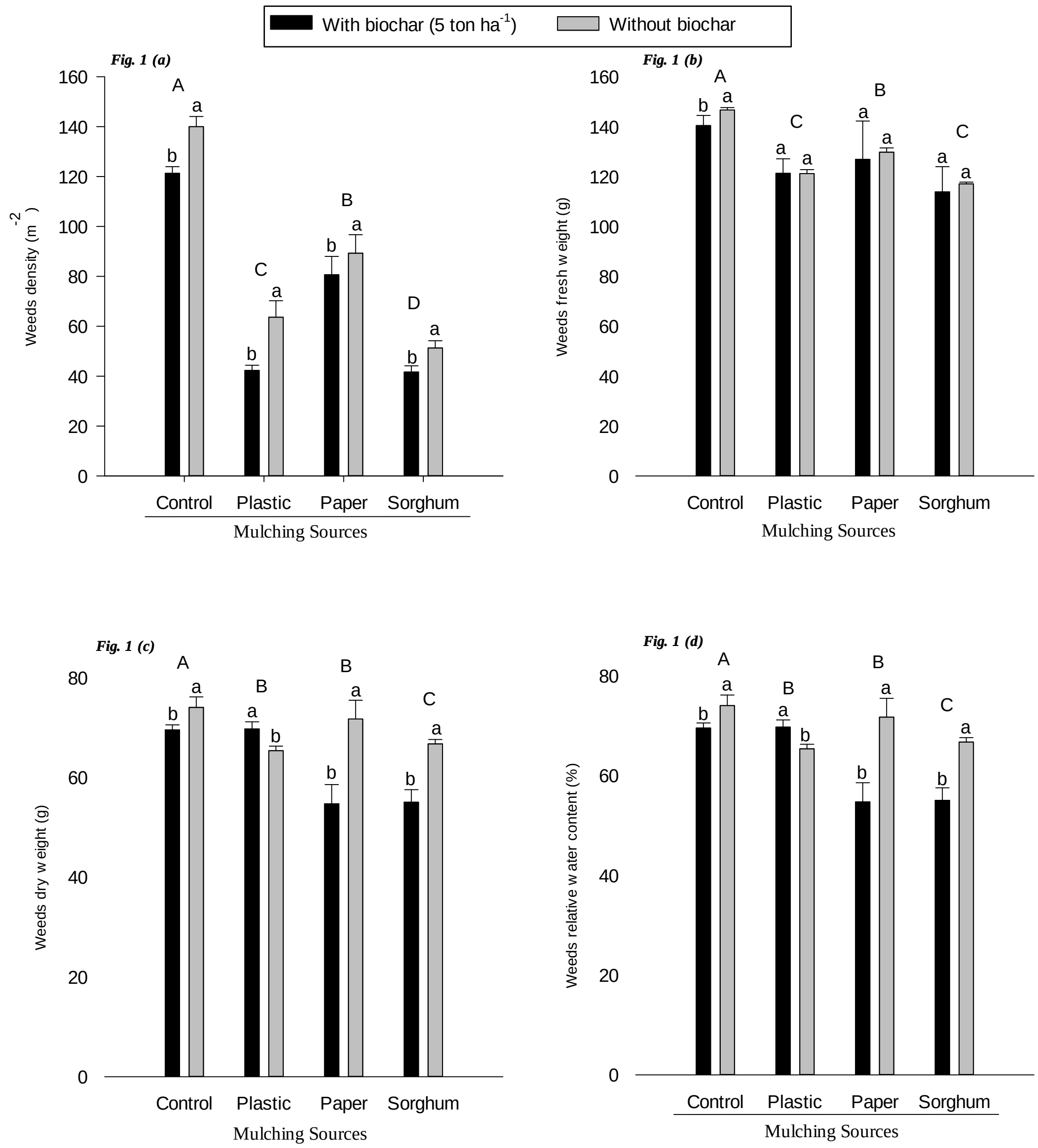

Figure 1. Changes over time in weeds density m^{-2}, weeds fresh and dry weight (50 Days after sowing), weeds relative water content in response to different mulching materials and organic amendments. Values represent means ± SEM (n = 3). Different capital letters above the represent significant differences between treatments at P < 0.05 level, while lowercase letters represent differences within an individual treatment at P < 0.05 level.

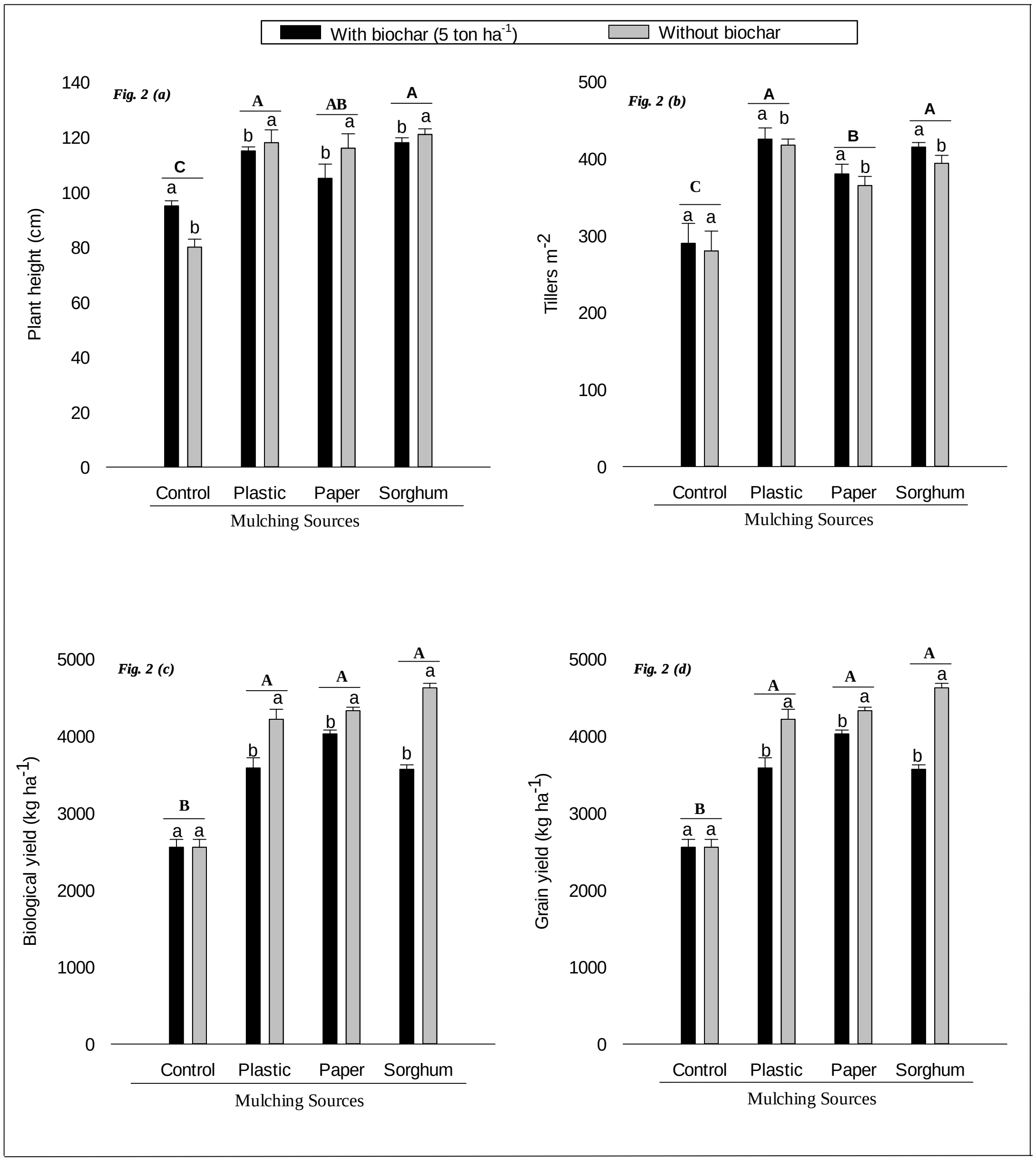

Figure 2. Changes over time in wheat plant height (cm), tillers m^{-2}, biological and grain yield (kg ha^{-1}) in response to different mulching materials and organic amendments. Values represent means ± SEM (n = 3). Different capital letters above the represent significant differences between treatments at P < 0.05 level, while lowercase letters represent differences within an individual treatment at P < 0.05 level.

REFERENCES CITED

Abouziena, H.F., A.A. Faida and E.R. Doseki. 2008. Efficacy of cultivar and weed control treatments on wheat yield and associated weeds in sandy soils. World J. Agric. Sci., 4(3): 384-389.

Ali, K., S. K. Khalil, F. Munsif, A. Rab, K. Nawab, A. Z. Khan, A. Kamal and Z. H. Khan. 2012. Response of maize to various nitrogen Sources and tillage practices. Sarhad J. Agric., 28(1): 09-14.

Ali, K., F. Munsif, M.Zubair, H. Akbar, Z. Hussain M. Shahid, I. Din and N. Khan. 2011a. Management of organic and inorganic nitrogen for different maize varieties. Sarhad J. Agric., 27(4): 525-529.

Ali., K, F. Munsif, Z. Husain, I. Khan, N.Ahmad, N. Khan and M. Shahid. 2011b. Effect of different weed control methods on weeds and maize grain yield. Pak. J. Weed Sci. Res., 17 (4): 313-321.

Ali, R., S.K. Khalil, S. M. Raza and H. Khan. 2003. Effect of herbicides and row spacing on maize (Zea mays L.). Pak. J. Weed Sci. Res., 9(3-4): 171-178.

Arif, M., K. Ali, F. Munsif, A. Ahmad, W. Ahmad and K. Naveed. 2012. Effect of biochar, FYM and nitrogen on weeds and maize phenology. Pak. J. Weed Sci. Res., 18(4): 475-484.

Baumhardt, R.L and O.R. Jones. 2002. Residue Management and Tillage Effects on Soil Water Storage and Grain Yield of Dryland Wheat and Sorghum for a Clay Loam in Texas. Soil and Tillage Res. 68(2): 71–82.

Bristow, K.L. 1988. The role of mulch and its architecture in modifying soil temperature. Aust J Soil Res. 26: 269-280.

Dada, O.A and O.O. Fayinminnu. 2010. Period of weed control in okra as influenced by varying rates of cattle dung and weeding regimes. Not. Bot. Hort. Agrobot. Cluj., 38(1): 149-154.

Dixit, A and K.C. Gautam. 1996. Effect of atrazine on growth and yield of winter maize. Ann. Agric. Res.,17(2): 121-124.

El-Bially, M.E. 1995. Efficiency of atrazine with other herbicides used alone, in sequence or as tank mix in maize. Ann. Agric. Sci.,40 (2): 709-721.

Elliot, P.C and K. Moody. 1990. Evaluation of various weed control practices in maize (Zea mays) in Misamis Oriental. Philippine J. Weed Sci., 17: 39-50.

Farhad, W., M.F. Saleem, M.A. Cheema and H.M. Hammad. 2009. Efect of poultry manure level on the productivity of spring maize (Zea mays L). J. Anim. Plant Sci., 19(3):122-125.

Fathi, G., F. Ebrahimpoor and S.A. Siadat. 2003. Efficiency of single and integrated methods (chemical-mechanical) for weed control in Corn SC704 in Ahvaz climatic conditions. Iran. J. Agric. Sci., 34 (10): 187-197.

Gul, B., K.B. Marwat, M. Saeed and Z. Hussain. 2011. Impact of tillage, plant population and mulches on weed management and grain yield of maize. Pak. J. Bot., 43(3): 1603-1606.

Hassan, A.A.A. and M.K.A. Ahmed. 2005. The influence of some herbicides and additional hoeing in maize growth and yield and yield components. Int. J. Agric. Biol., 7(5): 708-711.

Huang, L., X.G.Li, X.E.Liu, X.J. Jiang, R.Y. Guo, G.B. Jing, Z. Rengel and F.M. Li. 2015. Plastic mulch stimulates nitrogen mineralization in urea-amended soils in a semiarid environment. Agron. J. 107: 921–930.

Hussein, H.F. 1997. Studies on dynamic changes in growth, nutrient contents and grain yield of maize plants under weed competitive stress conditions. Mansoura Univ. J. Agric. Sci., 22(3): 643-658.

Jan, M.T., P. Shah, P.A. Hollington, M.J. Khan and Q. Sohail. 2009..Agriculture Research: Design and Analysis, A Monograph. NWFP. Agric. Univ. Pesh. Pak.

Khaliq, T., T. Mahmood and A. Masood. 2004. Effectiveness of farmyard manure, poultry manure and nitrogen for corn (Zea mays) productivity. Int. J. Agric. Biol., 2: 260-263.

Khan, S.A., N. Hussain, I.A. Khan, M. Khan and M. Iqbal. 1998. Studyon weeds control in maize. Sarhad J. Agric., 14(6): 581- 586.

Li, S. and L. Xiao. 1992. Distribution and management of drylands in the people's republic of china. Adv. Soil Sci., 18: 147-302.

Major, J., C. Steiner, A. Ditommaso, N.P.S. Falcao and J. Lehmann.2005. Weed composition and cover after three years of soil fertility management in the central Brazilian Amazon: compost, fertilizer, manure and charcoal applications. Weed Biol. Manage., 5: 69–76.

Menalled, F.D., K.A.Kohler, D.D.Buhler and M. Liebman. 2005. Effectsof compost edswine manure on weed seedbank. J. Agric. Ecosys. Environ., 111:63–69.

Miyazawa, K., H. Tsuji, M. Yamagata, H. Nakano and T. Nakamoto.2004. Response of weed flora to combinations of reduced tillage, biocide application and fertilization practices in a 3-year crop rotation. Weed Biol. Manage., 4: 24–34.

Oerke, E.C. and U. Steiner. 1996. Abschtzung der Ertragsverlusteim Maisanbau. In Ertragsverluste und Pflanzenschutz– DieAnbausituationfr die wirtschaftlichwichtigstenKulturpflanzen-.German Phytomedical Society Series, Band: EugenUlmerVerlag, Stuttgart, 6, pp. 63-79.

Sarkar, S., M. Paramanick and S.B. Goswami. 2007. Soil temperature, water use and yield of yellow sarson (Brassica napus L. var. glauca) in relation to tillage intensity and mulch management under rainfed lowland ecosystem in eastern India. Soil Till. Res., 93:94-101.

Shinde, S.H., A.K. Kolage and R.L. Bhilare. 2001. Effect of weed control on growth and yield of maize. J. Maharashtra Agric. Univ., 26(2): 212-213.

Steel, R.G.D. and J.H. Torrie. 1984. Principles and procedures of statistics, 2nd ed., McGraw Hill Book Co., Singapore, pp.172-177.

Steiner,J.L.1989. Tillage and Surface Residue Effects on Evaporation from Soils. Soil Sci. Soc. America J., 53: 911–916.

Whalen, J.K., C. Chang, G.W.Clayton, and J.P. Carefoot. 2000. Cattle manure biochar amendments can increase the pH of acid soils. Soil Sci. Soc. Amer. J., 64: 962-966.

Zhang, F., M. Li, J. Qi, F. Li and G. Sun. 2015. Plastic film mulching increases soil respiration in ridge-furrow maize management. Arid Land Res. Manage., 29: 432–453.

Zhang, S., P. Li, X. Yang, Z. Wang and X. Chen. 2011. Effects of tillage and plastic mulch on soil water, growth and yield of spring-sown maize. Soil Till. Res., 112: 92–97.