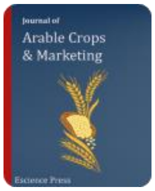
OPEN ACCESS J. Arab. Crops Market. 06 (02) 2024. 63-67 DOI: 10.33687/jacm.006.02.5639



Available Online at EScience Press
Journal of Arable Crops and Marketing
ISSN: 2709-8109 (Online), 2709-8095 (Print)
https://esciencepress.net/journals/JACM

Impact of Narrow and Broad leaf weeds on growth and productivity of maize under ridge and drill planting methods

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ABSTRACT

Weeds not only significantly impact crop quality by introducing unwanted seeds, which lowers the overall market value but also compete with maize for essential resources such as sunlight, water, and nutrients. Broad and narrow leaf weeds have a varying impact on productivity of maize. Furthermore, drill and ridge sowing are popular methods of maize among the farming community. Behavior of weed dynamics, including broad and narrow leaf weeds was investigated in a field experiment under both sowing methods of maize at Research Farm, Institute of Agronomy, Bahauddin Zakariya University Multan. Full season competition with weeds reduced the growth and yield related traits including plant height, cob length, cob diameter, grain rows, biological yield and a 31% reduction grain yield. Broad and narrow leaf weeds reduced the grain yield by 29% and 25% respectively. Findings of this research suggested that weeds in general but broad leaf weeds in particular are more harmful, so, proper weed control strategies should be employed for better harvest.

Keywords: Broad leaf weeds, narrow leaf weeds, drill sowing, ridge sowing.

INTRODUCTION

Maize (*Zea mays* L.) is the mostly produced cereal crop in the world, surpassing both rice and wheat. In the 2024/25 crop year, global maize production is projected to exceed 1.2 billion metric tons, while wheat production is estimated at approximately 793.24 million metric tons (Shahbandeh, 2025). This position is maize as the leading cereal crop globally, followed by wheat and rice. Maize holds substantial economic significance both globally and within Pakistan. Globally, maize is one of the most produced and traded cereal crops, serving as a fundamental component in food, feed, and industrial sectors. In the United States, for instance, maize farming yielded about 151 billion US dollars in total economic output, contributing approximately 62 billion US dollars to the GDP (Swanson, 2024). This underscores maize's pivotal role in agricultural economies and their extensive linkages across various industry sectors. In Pakistan, agriculture contributes about 22.9% to the GDP and employs 37.4% of the labor force (GOP, 2023). Within this sector, maize stands as the third most important cereal crop after wheat and rice. In the fiscal year 2024-25, maize production in Pakistan reached 9.84 million tons, cultivated over approximately 1.64 million hectares (Economic Survey of Pakistan, 2024). This production supports various industries, including food processing and livestock feed, highlighting maize's integral role in Pakistan's agricultural economy.

Amongst the various factors that lower the maximum maize production, weeds are considered as the foremost factors limiting the maize crop yield. In general, weed may massively reduce maize yield but sometimes it may lead to complete failure of the maize outputs.

Weeds significantly impact crop quality by introducing unwanted seeds, which lowers the overall market value. They also compete with maize for essential resources such as sunlight, water, and nutrients, and in some cases, release allelopathic chemicals that hinder crop growth. As a result, weed infestation remains a major economic challenge in maize production. Ultimately, weeds are considered a big challenge in successful maize production. It has been reported that weeds may decrease the maize yield by up to 65% (Mukhtar et al. 2007). In Pakistan, various weeds have been reported in maize fields, among these Horse purslane, Johnson grass, Purple nutsedge, Bermuda grass, Jungle rice and False amaranth are dominant species (Riaz et al., 2007).

Similarly, each sowing method has specific impact on the associated weed flora (Farooq and Cheema, 2014) that help in controlling weed pressure and ultimately their control. Recent studies have demonstrated that the choice of sowing method in maize cultivation significantly influences weed flora dynamics. Ridge sowing, characterized by planting maize on raised beds, has been associated with reduced weed biomass compared to flat sowing methods. This reduction is attributed to the physical disruption of weed seed distribution and germination patterns inherent in ridge tillage systems. For instance, a study observed that continuous ridge tillage without periodic ridge rebuilding led to higher weed seed bank densities, whereas regular ridge truncation and rebuilding effectively minimized weed infestations (Alagbo et al., 2022). Moreover, integrating ridge sowing with additional weed management practices, such as intercropping and mulching, has been shown to further suppress weed growth and enhance maize yields. These findings underscore the importance of selecting appropriate planting patterns and integrated weed management strategies to optimize maize production and control weed proliferation (Singh et al., 2020). Keeping in view the aforementioned information, experiment was planned to check the behavior of narrow and broad lead weeds on the growth and productivity of drill and ridge planted maize.

MATERIALS AND METHODS

A field trial was executed at Research Farm, Institute of Agronomy, Bahauddin Zakariya University Multan, Pakistan, to scrutinize the growth and productivity of drill and ridge planted maize as influenced by narrow leaf weeds and broad leaf weeds. The trial has two factors: sowing methods, including drill and ridge sowing, while the other factor is weed dynamic, including weedy check (weeds remain in competition for the whole season), complete weed free, competition with narrow leaf weeds and competition with broad leaf weeds. These treatments were set in a randomized complete block design having three replicates with a split plot arrangement. Planting geometry was set as plant-to-plant distance at 25 cm and row to row distance at 75 cm, whereas net plot size was 15 m2.

The experimental plot was prepared by following standard protocols, including the application of first irrigation, locally called as “Rauni” then at the onset of workable moisture conditions, double cultivations followed by planking and finally rotavating the field to get ideal seed bed. Sowing methods were kept in main plots, while weed treatments were in sub-plots. Maize hybrid Monsanto-6724 was purchased from the company Mansanto Pvt. Ltd. Fertilizers were added following the recommendations of the Maize & Millets Research Institute, Yousafwala, Sahiwal that is, nitrogen (N): 110 kg, phosphorus (P_2O_5): 58 kg and potassium (K_2O): 37 kg. At sowing, whole phosphorus, potassium and one-third of nitrogen were applied, while two other splits of nitrogen were applied with the 2nd and 3rd irrigations. During the whole crop season, 8 irrigations were done in total with an average 10 days interval. As per treatment requirements, weeds were manually removed or maintained. For controlling borer attacks, Furadon, a commercial insecticide, was applied at a 20 kg per hectare dose. Crop parameters like biological yield, grain yield, harvest index, plant height, maize cob length, cob diameter, grain rows per cob, number of grains per row, number of grains per cob, and finally 1000-grain weight were recorded using standard procedures, ensuring accuracy and reliability.

Statistical Analysis

The data were analyzed using analysis of variance (ANOVA) and means were performed by using Tukey's HSD test at $p < 0.05$ through Statistix-8.1 software to evaluate the difference among collected attributes means (Steel and Torrie, 1997).

RESULTS

Data presented in Table 1 revealed that interaction between maize sowing methods and weeding treatments was statistically significant for cob length, cob diameter, grains rows per cob and grains per cob. Maximum values for these parameters were recorded where weeds were remained controlled throughout the growing season and both sowing methods, (ridge and drill) were adopted (W1S1, W1S2) except results for cob length where maximum cob length was obtained where weeds were remained under control for whole growing season and maize was planted with ridge sowing technique (W1S1) and this was followed by W1S2. Grain rows per cob obtained in W3S1 was also statically at par with W1S1, W1S2. Whereas, minimum cob length, and cob diameter was obtained in drill sown maize plots with weed remained in competition for the whole growing season (W2S2). Minimum grain rows per cob and grains per cob were counted in weedy check plots with maize under both sowing methods (W2S1 and W2S2). In comparison of broad leaf and narrow leaf weedy check plots under both sowing methods of maize almost similar results were obtained.

Data regarding thousand grains weight, grain yield and biological yield presented in Table 2 explained that interaction between maize sowing methods and weeding treatments was non-significant, however, it was significant for harvest index (HI). Nonetheless, individual effects of sowing methods and weeding treatments for these parameters were statistically significant (Table 2). Among weeding treatments, maximum and minimum thousand grains weight, grain yield and biological yield was obtained where weeds were removed and weeds were remained in competition for whole season respectively (W1 and W2). While in comparison of both sowing methods, data for thousand grain weight was significant where ridge sowing surpassed drill sowing by getting higher values. For grain yield and biological yield results obtained under both sowing methods were non-significant. In case of interaction between maize sowing methods and weeding treatments for HI, maximum values were obtained where ridge planted maize faced weed free growing season (W1S1), while minimum HI was recorded where ridge and drilled maize faced competition with both narrow and broad leaf weeds (W3S1, W3S2, W4S1 and W4S2).

Maximum values for these parameters were recorded where weeds were remained controlled throughout the growing season and both sowing methods, (ridge and drill) were adopted (W1S1, W1S2) except results for cob length where maximum cob length was obtained where weeds were remained under control for whole growing season and maize was planted with ridge sowing technique (W1S1) and this was followed by W1S2. Grain rows per cob obtained in W3S1 was also statically at par with W1S1, W1S2. Whereas, minimum cob length, and cob diameter was obtained in drill sown maize plots with weed remained in competition for the whole growing season (W2S2). Minimum grain rows per cob and grains per cob were counted in weedy check plots with maize under both sowing methods (W2S1 and W2S2). In comparison of broad leaf and narrow leaf weedy check plots under both sowing methods of maize almost similar results were obtained.

Table 1. Interactive effect of different weeds-based treatment and sowing methods on the cob length, cob diameter, grain row cob^{-1} and grain cob^{-1}.

Weeding Treatments	Cobs Length (cm)			Cob Diameter (cm)			Grain Rows Cob-1			Grains Cob-1		
	Sowing Methods			Sowing Methods			Sowing Methods			Sowing Methods		
	S1	S2	Means	S1	S2	Means	S1	S2	Means	S1	S2	Means
W1	30.57a	28.07b	29.32 A	4.87a	4.85a	4.87 A	15.33a	15.34a	15.33 A	530.00a	503.33a	516.67 A
W2	20.80e	19.87f	20.33 C	3.89e	3.79f	4.47 D	13.33c	13.34c	13.32 C	281.67d	238.00d	259.50 D
W3	23.33c	22.13d	22.73 B	4.44c	4.29d	4.77 C	14.67ab	14.10bc	14.16 B	387.00bc	351.33c	369.17 C
W4	22.87cd	22.93cd	22.90 B	4.58b	4.34d	4.80 B	14.00bc	14.33b	14.33 B	428.00b	439.00bc	410.83 B
Means	24.39A	23.25B		4.45	4.32		14.34	14.25		399.92	378.17	
LSD	S= 0.42; W= 0.60; S×W= 0.85			S= 0.05; W= 0.07; S×W= 0.10			S= 0.36; W= 0.51; S×W= 0.73			S= 0.05; W= 0.07; S×W= 0.10		

W1 = Weed free, W2 = Weedy check, W3 = Broad leaf Weedy check, W4 = Narrow leaf Weedy check
S1 = Ridge sowing, S2 = Drill sowing; LSD= Least Significant Difference at 5% Probability level.

Table 2. Interactive effect of different weeds-based treatment and sowing methods on the 1000 Grains weight, Grain yield, biological yield and Harvest index.

Weeding Treatments	1000-grains Weight (g)			Grain Yield (Kg ha-1)			Biological Yield (Kg ha-1)			Harvest Index (%)		
	Sowing Methods			Sowing Methods			Sowing Methods			Sowing Methods		
	S1	S2	Means	S1	S2	Means	S1	S2	Means	S1	S2	Means
W1	315.00	300.00	307.50 A	4744.30	4636.70	4690.50 A	8713.30	8867.00	8790.20 A	58.48a	52.30b	50.29 B
W2	236.67	215.00	225.33 D	3232.00	3205.00	3218.50 C	7334.00	7033.30	7186.20 C	43.23bc	44.44bc	54.33 A
W3	265.00	243.33	254.17 C	3425.70	3263.30	3344.50 C	7892.00	7862.70	7877.30 B	44.20e	43.36e	43.77 C
W4	275.67	281.00	278.83 B	3574.30	3496.70	3535.50 B	7970.00	7802.30	7883.70 B	45.99de	43.11e	44.54 C
Means	273.08 A	259.83 B		3744.10	3650.40		7977.30	7891.30		49.17 A	47.30 B	
LSD	S= 3.96; W= 5.60; S×W= 7.92			S= 113.67; W= 160.75, S×W= 227.34			S= 236.40; W= 333.81; S×W= 472.08			S= 1.72; W= 2.42; S×W= 3.43		

Fig W1 = Weed free, W2 = Weedy check, W3 = Broad leaf Weedy check, W4 = Narrow leaf Weedy check
S1 = Ridge sowing, S2 = Drill sowing; LSD= Least Significant Difference at 5% Probability level

DISCUSSION

Results obtained from this research are very important in planning future studies regarding weed dynamics and planting methods of maize. The interaction between weed dynamics and sowing methods plays a significant role in determining maize cob characteristics such as cob length, cob diameter, grain rows per cob, and grains per cob. Weed-free conditions resulted in the longest cobs and largest diameters, as uncontrolled weeds compete for nutrients, water, and light, reducing maize growth and reproductive development (Ali et al., 2021). Among weedy treatments, broadleaf weeds caused a greater reduction in cob size and grain number than narrow-leaf weeds, likely due to their aggressive growth and shading effects (Chauhan and Johnson, 2011). Additionally, ridge sowing significantly improved cob traits compared to drill sowing, as ridges enhance soil aeration, root expansion, and weed suppression, leading to better grain filling (Iqbal et al., 2020). The weed-free ridge sowing treatment produced the longest cobs, widest diameters, and highest grain numbers per cob, demonstrating that effective weed control and optimized row spacing collectively enhance maize productivity (Singh et al., 2018). Broadleaf weeds caused greater reductions in grains per cob compared to narrow-leaf weeds, likely due to their rapid growth rate, higher biomass production, and ability to suppress maize growth (Ashiq et al., 2022).

Ridge sowing significantly improved grains per cob over drill sowing, due to better plant spacing, enhanced soil moisture retention, and reduced weed interference (Zhang et al., 2019). These findings highlight that maintaining weed-free conditions and adopting ridge sowing can maximize maize yield components. These findings further emphasize the need for integrated weed management and strategic sowing methods to maximize maize yield potential. Weed-free plots had the highest g rains per cob, indicating that early weed removal ensures optimal nutrient partitioning (Shahzad, 2016).

The interaction of weed strategies and sowing methods was however non-significant for thousand grains weight (TGW), grain yield, biological yield but significant for Harvest Index (HI) in maize. Weed-free plots consistently exhibited the highest TGW and grain yield, as the absence of weed competition allows for optimal nutrient uptake and grain filling (Ali et al., 2021). In contrast, weedy check treatments, particularly broadleaf weed infestations, led to substantial yield reductions, as these weeds aggressively compete for resources and suppress maize growth (Chauhan and Johnson, 2011). Among sowing methods, ridge sowing outperformed drill sowing, resulting in higher biological yield and harvest index, likely due to improved root development, better soil aeration, and reduced weed pressure (Iqbal et al., 2020). The weed-free ridge sowing treatment recorded the highest values across all parameters, highlighting the importance of integrated weed control and strategic sowing practices for maximizing maize productivity (Singh et al., 2018). These results emphasize that effective weed management combined with ridge sowing enhances grain quality, overall biomass production, and economic yield efficiency.

CONCLUSION

Overall, this research concluded that weeds pose a serious threat to productivity of maize. Weeds if not controlled caused 31% reduction in maize yield, whereas broad leaf weeds also caused more damage to maize if compared with narrow leaf weeds. Grain yield losses by broad lead weeds and narrow leaf weeds were 29% and 25% respectively.

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