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Effect of Planting Methods and Nitrogen Sources on Yield, Yield Components and N-Uptake of Spring Maize

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Abstract

A field experiment was conducted to evaluate effect of different planting methods and nitrogen sources on yield and yield components of spring maize at Agronomy Research Farm, The University of Agriculture, Peshawar during spring 2016 and 2017. Research work was carried out in randomized complete block design having total number of four replication. Different planting methods (ridge, raised bed and flat) were assigned to main plot while different nitrogen sources (poultry manure, FYM, urea and press-mud) were allotted to sub plots. Organic manures were applied manually into soil one week before maize sowing. Analysis of data showed that all parameters of spring maize were significantly affected by different planting methods except N-uptake. Maximum grain yield (3695 kg ha^{-1}), biological yield (9485 kg ha^{-1}) and grains ear^{-1} (393) were recorded in ridge planting method. Similarly, all yield parameters were also significantly affected by different nitrogen sources. Maximum grain yield (4350 kg ha^{-1}), biological yield (10103 kg ha^{-1}), grains ear^{-1} (449) and total N-uptake were recorded in poultry manure applied plots. Thus, it is concluded that ridge planting method and poultry manure resulted maximum grain yield and biological yield of spring maize as compared to other treatments.

Keywords: Spring maize; Planting methods; Nitrogen sources; Yield; Nitrogen uptake

Introduction

Maize (*Zea mays* L.) is an exhaustive cereal crop and can be used as food for human, feed for livestock and raw material for industries such as rafan etc. [1]. Among cereal crops maize occupied third position after wheat and rice in Pakistan while it comes on second position after wheat in Khyber Pakhtunkhwa. Due to its high productive potential it is often referred as 'king of grain crops'. According to agriculture statistics of Pakistan in 2014-2015 maize production was 4.936 thousand tones having total cultivated area of 1142.5 thousand hectares in Pakistan and in same year in Khyber Pakhtunkhwa it was cultivated on 463-thousand-hectare area having production of 909.7 thousand tones [2]. Among the modern agro-management techniques planting method is one of the crucial factor for improving crop yield. Different planting methods are practiced in the world for maize sowing. Ridge planting can be considered as alternative to no tillage practices. Abdullah [3] documented that ridge method of planting significantly increased yield of maize crop in comparison with other planting methods. Conventional flat planting has some disadvantages for spring maize. It causes crusting of soil and contributes to degradation of some soil properties which causes lodging of soil. Raised bed planting system with plantation of maize crop in defined rows on top of beds can overcome this problem. Considerable work has been done in this aspect, but efforts are still required to get higher yield from sweet corn by improving these techniques. Nitrogen is one of the major plant nutrient and play an active role in plant growth and development. FYM, press mud and poultry manure are organic sources of nitrogen which can be used instead of chemical fertilizers for getting higher yield of crops. Continuous application of chemical fertilizers in the soils cause toxicity, depletion of soil fertility and decreases activities of soil microorganisms. Organic manures are the best substitute of chemical fertilizers for improving soil fertility. Poultry manure contains highest percentage of N, P, K and is valuable organic manure [4]. Fertilization of poultry manure supplies higher amount of Phosphorus to plants than other organic fertilizers [5]. Press mud is a byproduct of sugar mills which can be separated from sugarcane juice. Press mud is a valuable source of essential plant nutrients [6]. FYM is an important organic fertilizer and increases maize yield, soil organic matter and soil fertility on sustainable basis [7]. Keeping in view the importance of planting methods and nitrogen sources for achieving higher grain yield from maize the present study was planned to study the effect of planting methods and nitrogen sources on yield and yield components of spring maize.

Experimental Procedure

The research trail was conducted in Agronomy Research Farm, The University of Agriculture, Peshawar during spring 2015 and 2016. The treatments comprised three planting methods (ridge, raised bed and flat) and four different nitrogen sources (poultry manure, FYM, press mud and urea). The field research was carried out in Randomized Complete Block Design (RCBD) in split plot arrangements keeping planting methods in main plots and different nitrogen sources in subplots. Desired amount of 200 kg N ha^{-1} were fulfilled from all these sources. Control treatment was also included in the trail. Organic nitrogen sources were applied manually one week before maize sowing. Net plot size was 4 m × 4.2 m.

Data recording procedure

For recording ear length five ears were randomly selected from each plot and their length were measured with measuring tape and then average was worked out. Grain rows ear^{-1} were determined by counting grain rows per ear of five randomly selected ears and then averaged. Grains ear^{-1} data were recorded by selecting five ears randomly from each plot. Grains from each ear was hand thrashed and were counted and then average were worked out. Thousand grain weight were recorded by counting thousand grains from grain sample of each plot of maize and was weighed with an electronic balance. Biological yield was recorded by harvesting three central rows from each plot. It was then placed in the sun for proper drying and weighted with spring balance and then averaged worked out. Grain yield data were recorded by harvesting three central rows from each sub plot. Grain samples were then dried in sun, threshed and grains were weighted with the help of an electronic balance and data was converted into kg ha^{-1}.

Grain yield (kg ha^{-1})=(Grain yield (kg) in three central rows/ No of rows harvested × Row length × R-R distance) × 10000

Nitrogen Uptake (kg ha^{-1}) was determined through; TDM × N concentration in plant/(100).

Statistical analysis

Data recorded was statistically analyzed according to analysis of variance technique appropriate for RCB design using Statistics 8.1 software. The treatment means was compared at $p \leq 0.05$ using LSD test [8].

Results and Discussion

Ear length (cm)

Ear length of spring maize was significantly ($p \leq 0.05$) affected by planting methods and nitrogen sources. Maximum ear length (18.5 cm) was recorded in ridge planting method. This might be due to more moisture availability and good crop stands in ridge because crop can get more porous soil and better root penetration in to soil which increases utilization of nutrients. These results are in line with Khan [9] reported that ridge sowing influence ear length more than other planting methods. Minimum ear length (14.0 cm) were recorded in flat planting which was statistically at par with ear length observed in raised bed (16 cm). Among different nitrogen sources maximum ear length (19.9 cm) were recorded with application of poultry manure. Minimum ear length (13.4 cm) were recorded in control plots. The reason for maximum ear length with poultry manure application may be due to more photosynthetic activities of the plant on adequate supply of nutrients because poultry manure has narrow C:N ratio which increases mineralization and ensure availability of nitrogen for entire growth season of crop. These results were confirmed by Amjad [10] reported a significant increase in ear length of maize by increasing rates of nitrogen from different nitrogen sources.

Grain rows ear^{-1}

Grain rows ear^{-1} is an important yield determine the final yield of maize crop. Grain rows ear^{-1} was significantly ($p \leq 0.05$) affected by different planting methods and nitrogen sources (Table 1). Ridge planting method results maximum number of grain rows ear^{-1} (14). These results are supported by Shahzad et al. [11] who confirmed that maize sown on ridge resulted maximum number of grain rows ear^{-1}. Flat and raised bed did not show any significant variation for grain rows ear^{-1}. Similarly, maximum grain rows ear^{-1} (15) were recorded in poultry manure fertilized plots. Minimum grain rows ear^{-1} (10) were recorded in control plots.

Physical Chemical Properties	Units	Values
Clay	%	19.7
Silt	%	44.8
Sand	%	35.5
Texture Class	-	Loam
pH	-	6.82
Electrical Conductivity (EC)	ds m^{-1}	0.4
Organic Matter (OM)	%	0.78
Lime Content	%	5.6
AB-DTP Ext. P	mg kg^{-1}	2.9
AB-DTP Ext. K	Mg kg ha^{-1}	104

Table 1: Physio-chemical properties of soil before sowing.

Grains ear^{-1}

Grains ear^{-1} is an important yield determining factor and contributes a lot to final grain yield of maize crop. Different planting methods showed significant differences ($p \leq 0.05$) for grains ear^{-1}. Ridge planting method resulted maximum grains ear^{-1} (393), while minimum grains ear^{-1} (354) were recorded in flat method of planting. This might be due to availability of more aerated and well fertile soil. These results are supported by Arif et al. [12] and Bakht et al. [13] concluded maximum grain ear^{-1} from ridge planting method. Among nitrogen sources poultry manure fertilized plots resulted maximum grains ear^{-1} (449). This increase might be due to abundant supply of nutrients epically nitrogen from poultry manure which enhanced source efficiency and grain weight. These results are in accordance with those of Saleem [14] and Hossain et al. [15] reported that application of organic fertilizer significantly affected number of grains ear^{-1} in maize crop. Control plots produced lesser grains ear^{-1} (317).

1000 grain weight

Analysis of data showed that grain weight was significantly ($p \leq 0.05$) affected by different planting methods. Higher grain weight (338.5 g) was recorded in ridge planting method. Increase in grain weight in ridge planting method might be due to the fact that ridge method of planting provides proper aeration of soil which enhanced uptake of nutrients from soil. This fact was also supported by Sandhu and Hundal [16] and Muhammad et al. [17] who recorded maximum grain yield in ridge sowing. Minimum thousand grain weights (303 g) were recorded in flat planting method. Likewise, poultry manure applied plots resulted maximum grain weight (354.5 g). As poultry manure are organic fertilizer which slowly decomposed and provide nutrients to the crop through-out in its growing season. Comparable significant results were also reported by Sahoo and Panda [18].

Biological yield

Biological yield was significantly ($p \leq 0.05$) affected by planting methods and nitrogen sources (Table 1). Ridge planting resulted maximum biological yield (9485 kg ha^{-1}) while minimum biological yield (8146 kg ha^{-1}) were recorded in flat planting method. The possible might be that ridge provide better soil environmental condition for root penetration which enhanced uptake of nutrients from soil. Siddique and Bakht [19] and Khan and Shafi [20] also obtained highest biological yield from ridge sowing. Similarly, maximum biological yield (10103 kg ha^{-1}) was recorded in poultry manure applied plots. The increase in biological yield reflects the better growth and development of the plants and proper utilization of nutrients by crop throughout the growing season. These results are in consonance with [21].

Grain yield (kg ha^{-1})

Planting methods and nitrogen sources significantly ($p \leq 0.05$) affected grain yield of spring maize. Maximum grain yield (3695 kg ha^{-1}) was recorded in ridge planting method. This might be due to the fact that ridge provides a better soil environmental condition for root penetration and increase uptake of nutrients and ultimately improves yield contributing factors as compared to other planting methods. Significant effect of ridge plantation on grain yield ha^{-1} and its components has also been reported by Khokhar et al. and Bhagwan et al. [22,23]. Likewise, maximum grain yield (4350 kg ha^{-1}) was recorded in plots fertilized with poultry manure followed by urea applied plots (4142 kg ha^{-1}). Increase in grain yield by poultry manure application may be due to more availability of nutrients in the soil and efficient utilization of these nutrients by the crop throughout growing season which improves crop growth and photosynthetic activities and resulted more grain yield. Similarly, Ayoola et al. [24] and Boatenget al. [25] also concluded from their research that poultry manure significantly increased grain yield.

N-uptake (kg ha^{-1})

Analysis of data showed that N-uptake were significantly ($p \leq 0.05$) affected by different N-sources, while planting methods had no significant ($p \leq 0.05$) impact on total N-uptake, similarly the interaction were also found non-significant (Table 2). Maximum N-uptake (97.7 kg ha^{-1}) was recorded in the plots applied poultry manure followed by N-uptake from Urea (82.4 kg ha^{-1}) and then FYM (78.7 kg ha^{-1}) fertilized plots. These results might be due to the minimum losses and availability of N from poultry manure (Figures 1 and 2).

Treatments	Ear Length (cm)	Grain rows ear^{-1}	Grains ear^{-1}	1000 G. Weight	Biological Yield	Grain Yield	Total N-Uptake
		Planting Methods					
Ridge	18.5 a	14 a	393 a	338.5 a	9485 a	3695 a	90.1
Raised bed	16.0 b	11 b	368 b	312 b	8500 b	3335 b	89.3
Flat	14.0 b	11 b	354 b	303 b	8146 b	3124 b	88.8
LSD (0.05)	0.68	1.09	18.24	20.59	961.32	286.74	-
		Nitrogen Sources					
Control	13.4 d	10 d	317 d	286.2 c	7467 e	2494 e	21.7 e
PM	19.9 a	15 a	449 a	354.5 a	10103 a	4350 a	97.9 a
FYM	15.1 c	12 c	338 c	310.3 bc	8645 c	3092 c	78.7 c
Press-mud	14.7 c	12 c	334 cd	303.6 c	7968 d	2846 d	69.3 d
Urea	17.8 b	13 b	421 b	334.5 ab	9368 b	4142 b	82.4 b
LSD (0.05)	0.922	1.16	18.36	25.83	404.87	175.88	2.189
Interaction	*(Figure 1)	ns	*(Figure 2)	ns	ns	ns	ns

Table 2: Ear length (cm), Grain rows ear^{-1}, Grains ear^{-1}, 1000 G. weight, Biological yield (kg ha^{-1}), Grain yield (kg ha^{-1}) and N-uptake (kg ha^{-1}) of spring maize as affected by planting methods and nitrogen sources. Means of the same category followed by different latters are significantly different from each other using LSD test at 0.05 level of probability, NS=Non-significant.

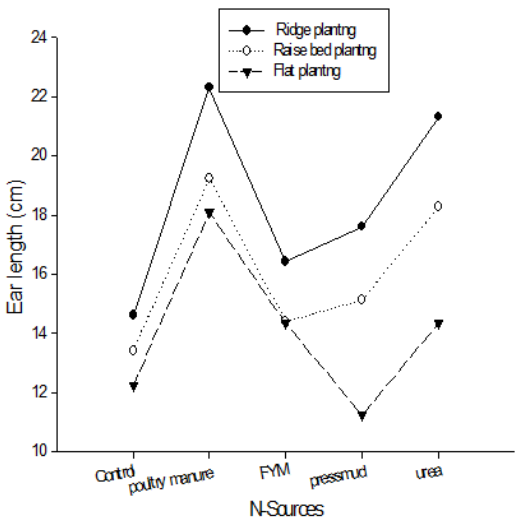

Figure 1: Interaction of planting methods and N-sources for ear length (cm) of spring maize.

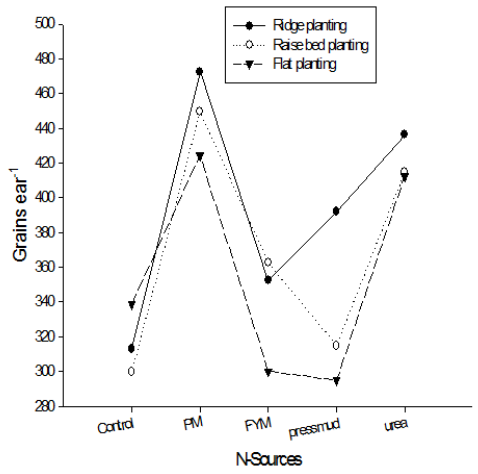

Figure 2: Interaction of planting methods and N-sources for grains ear^{-1} of spring maize.

Conclusion and Recommendations

Result presented in this study indicated that ridge planting method and poultry manure had a significant effect on all the parameters. Ridge planting and poultry manure performed better in all the studied parameter of maize. It is suggested that maize should be grown on ridges with the application of poultry manure in the agro-ecological condition of Peshawar.

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