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Influence of Compost Application and Seed Rates on Production Potential of Late Sown Maize on High Elevation in Swat -Pakistan

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Abstract
To evaluate the influence of compost application and seed rates on production potential of late sown maize on high elevation, an experiment was conducted at Farmer Field School (FFS), Swat Pakistan during summer 2013. The design of the experiment was used Randomized Complete Block Design (RCBD) with four replications. Sowing was done one month late (July 15th) than optimum time of sowing. Optimum time of sowing on high elevation in Swat-Pakistan starts from May 15th, to June 15th. Four levels of compost (5, 10, 15 and 20t ha^{-1}) and four seed rates (10, 20, 30 and 40 kg ha^{-1}) were used (cv. Baber). A subplot size of 3m x 4.5m was used. Each subplot was consisted of six rows having 75 cm row-to-row distance with row length of 3 m. Sowing of 40 kg seed ha^{-1}treated with 20 tonns compost ha^{-1}produced cob length (19 cm), plant height (179.19 cm), 1000 grain weight (192.83 g) and grain yield (2712 kg ha^{-1}). While maximum grain cob^{-1} gave by 30 kg seed ha^{-1} treated with 20 tonns compost ha^{-1}(375 grain cob^{-1}). On the basis of the above results, among the tested seed rate 40 kg ha^{-1}treated with20 tonns compost application is recommended for late sowing on high elevation in the agro-ecological conditions of swat valley.
Keywords: Maize (Zea mays L.), compost, seed rates, grain yield, yield components

INTRODUCTION

Maize (*Zea mays* L) is an important kharip crop and belongs to grass family or *Poaceae.* Maize is a multipurpose cereal crop of Pakistan as well as of the world (Imran, 2015). Its position is 3rd in term of cultivation after wheat and rice. It is cross pollination annual crop having thick, erect, and strong culm or stalk bearing nodes and internodes. Maize is basically tropical plant but presently it is extensively cultivated successfully in tropical, sub-tropical and in temperate regions (Imran, 2015).

Maize occupies a predominant position in farming system of Pakistan, because it is used as a staple food of rural population. Its grain is a rich source of fats (4.5%), protein (10.4%), starch (71.8%), vitamins and minerals like phosphorous, calcium and sulfur (Aslam*et al*. 2011). In Pakistan, area under maize cultivation is about 60% in irrigated region and cover about 36% in rain fed region (Tahir *et al*., 2009).

Maize is considered as a poly purpose crop. It provides raw materials to starch industry for preparation of many products. Its grain is used for preparation of alcohol, sugar, oil extraction, starch, lactic acid and acetones, and for other several industrials use (Imran, 2015). Maize oil is non-cholesterol oil and getting popularity for its non-cholesterol characteristics (Martin *et al*., 1975). It is grown extensively throughout the whole province of Khyber Pakhtunkhwa (Shah *et al*., 2007). Maize crop is mostly used livestock feeding, commercial starch and for oil production (FAO, 2007). Its two-third of the total production is used for these purposes.

Grain yield of maize crop is 583 kg ha^{-1} in Khyber Pakhtunkhwa that is very low as compared to other provinces of Pakistan (Imran, 2015). National average grain yield of maize crop in Pakistan is 3037 kg ha^{-1} (MINFA, 2009). Major causes of low maize yield in hilly, mountaniou and upper regions are declining soil fertility and insufficient use of Organic fertilizers like FYM, green manure and compost application (Imran, 2015). Maize requires healthy soil to supply adequate nutrients particularly nitrogen, Phosphorus and Potassium for good growth and high yield. Compost and organic material application to soil enhance nutrient supply and increase the availability of essential micro and macro nutrients to crop (Khan *et al*., 2008).Maize grain and biomass yields, number of rows and grains ear^{-1}, plant height and P_2O_5 uptake efficiency (PUE) of maize increased with organic material (Khan *et al.,* 2008)). There are a number of factors those affect maize yield considerably; however, in high elevation soil have less water retention capacity and poor in nutrients (Imran, 2015). Compost enhances microbial activities which improve soil structure and availability of nutrients. Maize differs in its responses to Seed rates (Luque*et al*., 2006). Aslam *et al*. (2011) reported that maize yield significantly varied under different seed rates. High yields result from high seed rates. However, higher plant populations increase competition among individual plants for water, sunlight and nutrients. This effect may lower individual plant yield but increase yield per unit area by optimizing yield components i.e. number of ears per unit area, number of kernels per ear and weight of each kernel (Imran, 2015). Keeping in view the significant role of compost application and seed rates in yield performance of maize crop, the present study was designed to investigate the effect of compost application and seed rates on yield and yield components of maize crop.

MATERIALS AND METHODS

To study the influence of compost application and seed rates on late sown maize in term of growth and yield in high elevation, field experiment was conducted at farmer field school Swat Pakistan during *kharif* season 2013.The experiment was laid out in randomized complete block (RCB) design having four replications. Four levels of compost (5, 10, 15, and 20 t ha^{-1}) and four seed rates (10, 20, 30 and 40 kg ha^{-1}) were used (cv. Baber). Sowing was done one month late than optimum time of sowing. A plot size of 3m x 4.5m was used. Each sub plot was consisted on 6 rows having 75 cm a part from each other. All the recommended agronomic practices were followed. Parameters studied and data were recorded on days to tasseling, days to silking, cob length (cm), plant height (cm), number of grain cob^{-1}, 1000 grain weight, biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}).Days to tasseling and silking were counted from the date of sowing to 50 % tasseling and silking. Plant height was measured at harvesting stage. Plant height was measured in randomly selected five plants form ground level to the last node with the help of measuring tape and then averaged. After harvesting, three cobs were randomly taken in each plot and number of grains cob^{-1}were counted and then averaged. After shelling the ears, thousand grains were taken from bulk of seed and weighted. Four central rows were harvested in each sub plot and after shelling of the ears in that rows grain yield was recorded and then converted to kg ha^{-1}.
Statistical analysis relevant to RCBD was analyzed upon significant F-Test, at LSD (least significance difference) $P \leq 0.05$ level (Jan *et al*., 2009).

RESULTS AND DISCUSSION

Days to tasseling

Significant differences were observed in days to tasseling. Early tasseling was observed (52 days) in plots treated with higher rate of compost (20 t ha^{-1}) whereas tasseling was delayed to 55.5 days in 5 tons compost treated plot (Table 1).Compost application enhanced days to tasseling. Enhancement in the phonological development of maize with higher rate of compost application may probably have increased root development and thus helped the plants obtained more nutrients to complete its life cycle earlier. With compost application rapid plant growth and development was also earlier reported by Hadda and Arora. (2006).Early tasseling was observed in 10 kg and 30 kg seed ha^{-1}(52 days) while maximum days taken to tasseling was observed in 40 kg seed ha^{-1}appliedplots.The possible reason could be that, minimum seed rate and optimum seed rate have more nutrients availability and uptake, through which economic plant does not compete with each other for light, nutrients, water, C O_2 and other essential requirements for plant that could be enhance days to tasseling while heighst seed rates have compatibility in all these essential requirements.

Days to silking

Perusal of the data revealed that earlier silking (57 days) was observed in plots treated with the application of highest level of compost (20 t ha^{-1}), whereas silking was delayed up to 60 days in those plots where compost was applied at the rate of 5 tonns. Seed rates significantly affected days to silking and earlier silking was observed in 30 kg ha^{-1} seed sown plots while the other seed rates were at par valued in this order. The findings of these results are closely associated and with conformity with those of Sarir*et al*. (2005) who reported that compost enhanced all growth parameters and grain yield. Enhancement in days to silking of maize with highest rate of compost application may probably have increased nutrients availability to roots and thus helped the plants to obtained more nutrients to complete its life cycle earlier. Rapid plant growth and development with the highest rate of compost application might be due to frequent supply of nutrients and might be due to microbial activity in provision of nutrients uptake by the plant. These findings are closely related with Sarir *et al*., (2005) who stated that corn plant start the reproductive phase as earlier with the abundant supply of nutrients.

Cob length (*cm*)

Statistical analysis of the data revealed that plots treated with compost application at the rate of 20 t ha^{-1}produced maximum cob length (19.10 cm) while minimum cob length was observed in 5 tonns compost treated plot (16.41 cm). While plots treated with 10 and15 tonns compost at par respectively. Similarly seed rates significantly affected cob length and maximum cob length was observed in 40 kg seed ha^{-1} treated Plots. While the others sowed seed rates were at par, having similar statistical value in this order. The reason for increased length of cob of maize due to higher level of compost application and seed rates could be that higher translocation of assimilates as well as nutrients absorption has accrued due to optimum plant population because nutrients mass flow and diffusions increases with nutrients uptake and has been resulted into increased cob lengths. Sahoo and panda (2001) also reported that length of cob increased with increasing nutrients availability.

Plant height (cm)

The analyzed data of plant height showed that compost levels, seed rates and interaction of S x C significantly affected plant height. Plant height positively responded with increase in compost level. Maximum plant height

(190.83 cm) was observed in plots treated with compost application at the rate of 20 t ha^{-1}followed by 15 tons treated plots which produce 182 cm plant height whereas minimum Plant height (167.58 cm) was observed in 5 tonns compost applied plot. Linear increased was occurred in plant height with the application of compost levels. As compost level increased from 5 to 20 t ha^{-1}, an incredible positive change in plant height was recorded. Seed rates also influenced plant height and maximum plant height was observed in 10, 30, and 40 kg seed ha^{-1}applied plots but statistically at par having 179.5 cm, 178.92 and 179.17 cm respectively. Interaction showed that short plants were observed in 10 kg seed ha^{-1} treated plots (170.67) with 5 tonn compost application. As the level of compost increased up to 20 t ha^{-1}tallest plants (195 cm) were observed in plots treated with 40 kg ha^{-1}seed rate. The results are conformity with those of Khaliq*et al*. (2004) who reported that plant height of maize plants increased with increasing organic material.

Grains cob-^{1}

Data analysis indicated that compost levels, seed rates and interaction of Sx C significantly affected number of grain cob^{-1}. Significant difference was observed in maximum compost treated plots as compared to minimum compost applied plots. Linear increase was occurred in grain cob^{-1}. Maximum number of grains cob^{-1} (381.5 grains cob^{-1}) was noted in highest level of compost (20 t ha^{-1}) treated plots followed by 15 and 10 t ha^{-1} applied plots (377, 363 grains cob^{-1}). Minimum (346 grains cob^{-1}) were observed in 5 tonn compost treated plot. Seed rates significantly affected number of grain cob^{-1}. Maximum grain cob^{-1}was noted in plots treated with 30 kg ha^{-1} (375.42 grain cob^{-1}) seed rate followed by 20 kg (369 grain cob^{-1}) and 40 kg ha^{-1}(365 grain cob^{-1}). While minimum grains cob^{-1} was observed in 10 kg seed ha^{-1}treated plots (358 grains cob^{-1}). Interaction showed that minimum grains cob^{-1}was observed in 10 kg seed ha^{-1}treated plots while maximum 398 grain cob^{-1} observed in 30 kg seed ha^{-1}treated Plots with 15 tonns compost application. The results are in accordance with those of Khan *et al*. (2008) who reported that organic fertilizer applications significantly affected the grains per cob.

Thousand grain weight (g)

Thousand grains weight was significantly affected by compost levels and seed rates. Interaction between S x C was non-significant. Maximum thousand grain weight (203 g) was recorded in 20 tonns ha^{-1} applied plots followed by 15 and 10 t ha^{-1}treated plots (190.25 and179.67 g).Whereas minimum thousand grain weights was recorded in 5 tonns compost application (171.58 g). Heaviest grain weight with higher compost level probably may be due to the higher nutrients absorption and translocation into the sink which resulted in highest grain weight (Amanullah *et al.*, 2009). Hadda and Arora. (2006) also suggested that increase in organic matter enhances grain weight in maize. Similarly seed rates significantly affected 1000 grain weight and maximum weight was recorded in 40 kg ha^{-1} seed treated plots (192.83g) while the other seed rates were at par respectively. The reason for increase in 1000 grain weight in seed rates might be due to more nutrients uptake with high mass flow and diffusion to root zone due to maximum compost application and seed rates. These findings are closely with conformity of Saleem (1990) who reported that application of farmyard manure (FYM) to soils with high pH, not only supply Phosphorous but increase the availability of indigenous nutrients.

Grain yield (kg ha^{-1})

Compost levels, seed rates and interaction of S x C significantly affected grain yield. Highest grain yield was obtained from plots received highest level of compost as compared to lowest level of compost receiving plot. The effect of all compost levels on grain yield was significantly different from one another. The highest grain yield (2318 kg ha^{-1}) was recorded in plots treated with compost at the rate of 20 t ha^{-1}followed by 15 tonn ha^{-1}(2068 kg ha^{-1}) while minimum grain yield was recorded in 5 tonn compost treated plots (1855 kg ha^{-1}). The increase in grain yield with increase in compost level probably may be due to the increase in cob length, number of rows and number of grains per cob as well as heaviest grain weight. The lowest grain yield in 5 tonn compost treated plot indicating higher demand for compost application. (Hussanin and Haq, 2000) and Ibrikci*et al.*(2005) suggested that organic matter and compost fertilizers are the rich source of NPK nutrients and its deficiency is a common crop growth and yield limiting factor. Seed rates also significantly affected grain yield and maximum grains yield 2712 kg ha^{-1} was recorded in plots sown with seed rate @ 40 kg ha^{-1}followed by 30 kg and 20 kg seed ha^{-1} produced grain yield 2174 and 1956 kg ha^{-1}. Whereas minimum grains yield 1334 kg ha^{-1} was recorded in 10 kg seed ha^{-1}treated plots. The reason for low grain yield probably may be due to insufficient seed rates. Higher grain yield can be achieved with proper seed rates and proper agronomic practices. Interaction showed significant difference in grain yield. Minimum grain yield was recorded in plots received 10 kg seed ha^{-1} and linearly increased with seed rates. A sharp increase was noted in plots received 40 kg seed ha^{-1}with compost application of 20 t ha^{-1}, and produced 3360 kg grain yield ha^{-1}followed by 30 kg seed treated with compost at the rate of 20 t ha^{-1}produced 2723 kg grain yield ha^{-1}.The increase in grain yield with increase in compost level probably may be due to the increase in cob length, number of rows and number of grains per cob as well as heaviest grain weight. These results are supported by Amanullah *et al.*,(2009), reported that grain yield was significantly boost up with frequently supply of nutrients.

Table 1. ***Days to tasseling, days to silking, and cob lengthof maizeas as affected by compost application and seed rates***

Compost (ton ha^{-1})		Days to tasselling	Days to silking	Cob length (cm)
	5	54.50c	59.83c	16.41c
	10	53.83b	58.41b	17.40b
	15	52.83a	58.00b	17.73b
	20	52.00a	56.75a	19.10a
$LSD_{(0.05)}$		0.84	0.60	0.89
Seed rates kg ha^{-1}	10	**52.58a**	**58.33b**	**16.83b**
	20	53.33a	58.83b	17.51b
	30	52.58a	57.50a	17.48b
	40	54.25b	58.33b	19a
$LSD_{(0.05)}$		0.84	0.60	0.89
Interaction	S X C	1.68	ns	Ns

Means in the same category followed by different letters are significantly different at P ≤0.05 level.
ns = non-significant

Table 2. ***Plant height, number of grains cob^{-1}, 1000, grain weight and grain yield of maize as affected by compost application and seed rates***

Compost (ton ha^{-1})		Plant height(cm)	Grains cob^{-1}	1000 G wt (g)	Grain yield (kg ha^{-1}
	5	167.58d	346.08d	171.58d	1855d
	10	174.00c	363.25c	179.67c	1936c
	15	182.00b	376.75b	190.25b	2068b
	20	190.83a	381.50a	203.42a	2318a
$LSD_{(0.05)}$		1.95	**4.59**	5.47	100.28
Seed rates kg ha^{-1}	10	**179.5a**	**358.08d**	**184.42b**	**1334d**
	20	176.83b	369.42b	186.00b	1956c
	30	178.92a	375.42a	181.67b	2174b
	40	179.17a	364.67c	192.83a	2712a
$LSD_{(0.05)}$		1.95	**4.59**	**5.47**	100.28
Interaction	S X C	3.91	9.19	Ns	200.55

Mean followed by different latters are significantly different at P ≤0.05 level.
ns = non-significant

CONCLUSION AND RECOMMENDATIONS

On the basis of above results, seed rate should be used 40 kg ha^{-1} for late sowing of maize with the application of compost at the rate of 20 t ha^{-1}in upland areas. It was observed that maximum cob length, plant height, highest number of grains cob^{-1}, maximum 1000 grain weight and significantly highest grain yield with the application of compost at the rate of 20 t ha^{-1}under the high elevation of swat valley condition.

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