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Research Article

Phenological traits of Maize influenced by integrated management of compost and fertilizer Nitrogen

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Abstract

Compost is mixture of organic residues contain animal dung and urine along with other residues, such as fodder ruminant, stubble, weeds and leaves. Composted organic material can be used as a source of important nutrients for sustainable crop productivity. Fertilization of maize with nitrogen is one of the most important management practice which affects growth and yield of the crop. Alternative forms of fertilizers such as manures (farmyard manures, composts, and green manures, liquid manure) can be used as sources of plant nutrients and at the same time increase N use efficiency and crop yield. Therefore the investigated study was designed to evaluate the response of maize to integrated management of compost type and Fertilizer-N a field trial was carried out at Agronomy Research Farm the University of Agriculture, Peshawar during kharif season 2012. The experiment was laid out in Randomized Complete Block Design (RCBD) having three replications and a plot size of $18m^2$ (4m x 4.5m) having 6 rows with 75 cm apart. All plots except control (no compost) were treated with compost from 3 various sources .i.e. cereal, legume and FYM in such a way that 150 kg N ha^{-1} was ensured based on nitrogen concentration. These plots either were supplemented with half of recommended N .i.e. 75 kg ha^{-1} from fertilizer (urea) or without fertilizer-N. Phosphorus was supplied at the rate of 75 kg ha^{-1}. Data were recorded on days to emergence, days to tasseling, days to silking, days to maturity and plant height. Results revealed that compost type significantly affected all parameters except days to maturity. Minimum days to emergence (6 days) were recorded in control, days to tasseling (56 days) in legume and days to silking (60 days) in FYM based compost with and without Nitrogen respectively. Optimum plant height (255 cm) was recorded in FYM compost. Mineral nitrogen were non-significant for all parameters. It was concluded from the data, that legume and FYM based composts either supplemented with N or not, had resulted optimum growth and phenology of maize, and thus is recommended for general cultivation in agro-climatic conditions of Peshawar.

Keywords: Maize (*Zea mays* L.); Compost types; Nitrogen; Growth and phenology

Introduction

Maize is an important *kharip* crop of Pakistan belongs to family gramineae. It is grown in summer in Pakistan as well as in spring season. It is a multipurpose crop of Pakistan ranked 3rd. It is an exhaustive and multipurpose cereal crop that provides food, feed for human and animals whereas raw material for the industries [1]. It has greater nutritional value as it contains about 72% starch, 10% proteins, 4.8% oil, 8.5% fiber, 3% sugar and 1.7% ash [2]. It is the third most important cereal crop after wheat and rice, while in the farming system of Khyber Pakhtunkhawa it ranks second after wheat in importance. It was grown on an area of 1083 thousand ha with total production of 4271 thousand tons and national average yield of 3943 kg ha^{-1} in Pakistan [3]. Compost is mixture of organic residues and soil that has been piled, moistened, and allowed to decompose in a pit or heap. It is mixed with soil prior to decay process. It may also contain animal dung and urine along with other residues, such as fodder ruminant, stubble, weeds and leaves [4]. Composted organic material can be used as a source of important nutrients for sustainable crop productivity. Fertilization of maize with nitrogen is one of the most important management practice which affects growth and yield of the crop [5]. N level has a direct effect on chlorophyll content [6]. Alternative forms of fertilizers such as manures (farmyard manures, composts, and green manures, liquid manure) can be used as sources of plant nutrients and at the same time increase N use efficiency and crop yield [7]. Crop yield is usually increased by manure application because of the increased nutrients availability and the improved soil structure [8]. Schlegel (1992) [9] found that composted manure plus fertilizer addition resulted in greater grain sorghum (*Sorghum bicolor* L.) yield than either source applied alone. However, [10] reported that compost increase grain yield of maize over control.

Use of proper organic and inorganic fertilizer combination, is a key factor in crop production for sustainable agriculture. However, there is limited published work about the application of compost manure along with the inorganic N fertilizer. The objective of this study was to determine the response of maize growth and productivity to compost manure and inorganic N fertilizer under the agro-climatic condition of Peshawar, Pakistan.

Materials and Methods

Field experiment was conducted at Agronomy Research Farm of The University of Agriculture Peshawar (Khyber Pakhtunkhawa, Pakistan) during Kharif, season 2012. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Compost quantities were calculated for supplying 150 Kg N ha^{-1} based on its chemical composition and applied at sowing either control mineral N or with half of the recommended fertilizer N i.e. 75 kg N ha^{-1}. N content of the composting materials were determined calorimetrically, following kjeldahl procedure [11]. The crop was sown on June 22, 2012. Plot size was 18 m^2 (4m × 4.5m) having 6 rows, 75 cm apart and 4 m long. Field was prepared with two ploughing followed by planking. Maize variety, Azam was used as test crop with seed rate of 25 kg ha^{-1} and was collected from Agronomy Research Farm, The University of Agriculture Peshawar. All other agronomic practices were carried out uniformly for all plots. Data was recorded by using standard methods according to days to emergence, days to tasseling, days to silking, days to physiological maturity and plant height. Days to emergence was calculated by counting the number of days from planting to date when 50% plants emerged in each

plot. Days to tasseling were calculated by counting the number of days from planting to date when about 50% plants produced tassels in each plot. Days to silking were calculated by counting the number of days from planting to date when about 50% plants developed silks in each plot. Days to physiological maturity was calculated by counting the number of days from planting to date when about 50% plant became physiologically mature. Yellowing of husk was taken as sign for physiological maturity. Plant height was calculated by measuring the height from the bottom to the top (Included tassel) of randomly taken 5 plants in each plot and was averaged. Data was statistically analyzed according to the procedure described by Steel *et al*. (1996) **[12]** for randomized complete block design and means were separated by least significant differences test ($P \leq 0.05$) upon significant F test.

Results and Discussion

Days to emergence

Data concerning days to emergence as affected by compost and nitrogen are presented in table 1. Statistical analysis showed that the effect of compost was significant while that of fertilizer N was non-significant. The interaction of fertilizer N and compost was also non-significant for days to emergence. Mean values of the data showed that cereal compost with and without nitrogen delayed days to emergence (8 days) as compared to legume and FYM based compost application (6 days each). Similarly no significant differences for days to emergence were observed among control, legume and FYM based compost. Cereal compost with and without nitrogen delayed days to emergence as compared to legume and FYM compost with and without Nitrogen respectively. This might be due to the compost impact on physical and chemical properties of soil which determines soil aeration, porosity, water retentivity and hence duration to emergence. This is supported by the findings of **[13]** who reported that compost application affected soil properties.

Table 1. Days to emergence of maize as affected by compost and Nitrogen.

	Nitrogen(kg ha^{-1})		
Compost	0	37.5 $	Mean
Control	6	6	6 b
Cereal based N	8	8	8 a
Legume Based N	6	6	6 b
FYM Based N	6	6	6 b
Mean	6	6	

$=half nitrogen applied at sowing time and half at knee stage

LSD value for compost (C) at $P \leq 0.05$ = 1.102

Fertilizer Nitrogen (N) = ns

Interaction (N x C) = ns

Days to tasseling

Data regarding days to tasseling as affected by compost and nitrogen application are presented in table 2. Statistical analysis showed that the effect of organic nitrogen was significant while fertilizer nitrogen was non-significant. The interaction among these were also non-significant for days to tasseling. Mean values of the data revealed that there were delayed tasseling was observed in cereal based compost with and without nitrogen (58 days) as compared to

legume and FYM based compost (56 days each). Compost incorporation had delayed tasseling, which might be due to more fertilizer availability and improved soil condition and fertility. Delayed tasseling due to higher N application could be associated with vigorous and prolongs vegetative growth as a result of higher nutrient availability [14]. This finding is supported by [15] who concluded that tasseling in maize was delayed when cereal compost was applied. These results were confirmed and supported by those of [16, 17] they reported that compost application along with different plant population and seed rate influenced phonological characteristics of maize crop. The reason could be that in highest seed rate competition for light, nutrients, water, CO_2 and others essential requirements for plants can increase days to tasseling.

Table 2. Days to tasseling, silking, physiological maturity and plant height (cm) of maize as affected by compost and Nitrogen.

Compost type	DTT	DTS	DPM	Plant height (cm)
Control	56 b	60 b	99	182.3 c
Cereal	58 a	63 a	98	227.5 b
Legume	56 b	60 b	98	253.3 a
FYM	56 b	60 b	98	255.0 a
LSD (0.05)	1.193	1.668	Ns	17.6
0	56	61	98	228.5
75	57	61	98	230.6
LSD (0.05)	Ns	ns	Ns	ns
C x N	Ns	ns	Ns	ns

Means followed by different letter (s) within each category are significantly different using LSD test at $P \leq 0.05$.

Days to silking

Data about days to silking as affected by compost and nitrogen is shown in (Table 2). Statistical analysis of the data indicated that organic nitrogen had significantly affected days to silking while fertilizer nitrogen had non-significant effect on days to silking. All the interactions were also non-significant for days to silking. Mean comparison of the data indicated that cereal based compost with and without nitrogen had delayed days to silking (63 days) as compared to legume based compost and FYM (60 days each).Similarly no differences were recorded among control, legume based and FYM based compost. Cereal compost had delayed days to silking. Delayed silking due to the increase of N might be due to the prolonged vegetative period. These results are in line with the findings of [14] who reported that compost application had delayed silking. These results were supported by [16-18] they concluded that compost application may enhance the growth parameters of lately sown maize crop. Rapid plant growth and development with the highest level of compost application probably might be frequent supply of nutrients to the crop plant and might be by the microbial activities with the incorporation of compost to the soil.

Days to physiological maturity

Data concerning days to physiological maturity as affected by compost and nitrogen is shown in Table 2. Statistical analysis of the data indicated that organic nitrogen and fertilizer nitrogen had non-significantly affected days to physiological maturity. Similarly the interactive response

of fertilizer nitrogen and organic Nitrogen were also found non-significant for days to physiological maturity. Compost incorporation had no effect on days taken to physiological maturity, which might be attributed to the peculiar genetic characteristics of the same variety. This finding is similar to the findings of **[19]** who reported that compost application had no effect on physiological maturity.

Plant height

Data regarding plant height at physiological maturity as affected by compost and nitrogen are revealed that compost had significantly affected plant height while fertilizer nitrogen had non-significantly affected plant height. The interaction among both of these were also non-significant for plant height. Mean comparison of the data indicated that FYM based compost with and without nitrogen had increase plant height (255 cm) as compared to cereal based compost and legume based compost (182.3 cm). These results were supported by **[16-18]** they concluded that compost application may enhance the growth parameters of lately sown maize crop. Rapid plant growth and development with the highest level of compost application probably might be frequent supply of nutrients to the crop plant and might be by the microbial activities with the incorporation of compost to the soil.

Optimum plant height in maize was observed with the application of FYM compost. Compost application had proliferated plant height, which might be due to more nutrients availability in rhizosphere and improved soil condition and fertility. This result is supported by the research work of **[17, 20]** who conducted field experiment and reported that plant height was significantly affected by FYM and fertilizer application. These results were confirmed and supported by those of **[16, 18, 21]** they reported that compost application along with different plant population and seed rate influenced phonological characteristics of maize crop. The reason could be that in highest seed rate competition for light, nutrients, water, C O_2 and others essential requirements for plants can increase days to tasseling. This is also in line with the report of **[17, 22]** who also reported that plant height was affected when compost was applied to the field.

Conclusion and Recommendation

It was concluded from the above results that legume and FYM based composts either supplemented with N or not, produced optimum growth and phenology of maize as compared to those plots treated with 75 kg N ha^{-1} had similar effects on maize growth and phenology and thus is recommended for general practices of maize cropping system.

Authors' contributions

Conceived and designed the experiments: B Iqbal, MT Jan & Z Muhammad, Performed the experiments: B Iqbal, Z Muhammad & K Shahzad, Analyzed the data: B Iqbal, MT Jan & Z Muhammad, Contributed reagents/ materials/ analysis tools: AA Khan, S Anwar & Imran, Wrote the paper: B Iqbal.

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