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EFFECT OF BIOCHAR, FYM AND NITROGEN ON WEEDS AND MAIZE PHENOLOGY

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ABSTRACT

The proper crop stand and efficient weed control are the two important determinants that directly or indirectly influence crop growth cycle and affect crop productivity. In Pakistan, maize production mainly relies on commercial fertilizers. Presently, the environmental pollution as a result of higher inorganic fertilization has become a burning issue in the field of agriculture. In this connection, in order to evaluate the impact of nitrogen sources on maize phenology and weed control, a field experiment was conducted at the New Developmental Farm of The University of Agriculture, Peshawar, Pakistan in 2011 in a randomized complete block design (RCBD) having three replications. The experiment comprised of 13 fertilizer treatments i.e. control, nitrogen alone (N), farm yard manure alone (FYM), biochar alone (BC) and their various combinations. Data were recorded on days to tasseling, silking and maturity and weeds density at 30 DAS and 60 DAS. All the parameters were significantly affected. Among the treatments biochar, N and FYM application at the rate of 25 ton ha^{-1}, 10 ton ha^{-1} and 150 kg ha^{-1} respectively delayed tasseling, silking and maturity in maize crop. Similarly, biochar application at the rate of 25 ton ha^{-1} and FYM at the rate of 5 ton ha^{-1} resulted in lower weeds population both 30 and 60 DAS. On the basis of our experimental results, biochar and FYM applications at the rate of 25 t and 5 t ha^{-1} are recommended for improving maize growth and efficient weed control.

Keywords: Biochar, FYM, maize, nitrogen, phenology, weeds.

INTRODUCTION

Maize (*Zea mays* L.) is an exhaustive cereal crop. It is a multipurpose crop that provides food for human, feed for animals especially poultry and livestock and raw material for the industries (Khaliq *et al*., 2004). It is the third most important cereal crop after wheat and rice while in the farming system of Khyber Pakhtunkhwa it range second after wheat in its importance. In 2010 it was cultivated on an area of 981 (000 ha) with a total production of 36581 (000 tons) in Pakistan and during the same season its area of cultivation and

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production in KP was 512 (000 ha) and 1468 (000 tons) respectively (FAO, 2010). Green revolution caused significant increase in crop production particularly in cereal crops like wheat, maize and rice in Pakistan. However, it is now shadowed by new challenges related to soil degradation such as erosion, decline of soil organic matter content, problems caused by continuous application of organic fertilizer and ever escalating prices of chemical fertilizers (Farhad *et al*., 2009). Increasing yield and decreasing production cost as well as to maintain soil health is newly emerging challenge for agricultural scientists. In order to meet these challenges researchers interest increase in bringing sustainability in agriculture. Several options are currently considered by researchers in order over come these challenges, these include, organic farming, integrated nutrient management and efficient weed control (Huang *et al*., 2007; Rasool *et al.,* 2007). To ensure increased yield of maize, there is need to intensify efforts on judicious use of the available land through application of proper fertilizer especially nitrogenous fertilizer with appropriate weed control. Nitrogen fertilization plays significant role in improving soil fertility and increasing crop productivity. N fertilization results in increased maize yield (43-68%) and biomass (25-42%) (Ogola, *et al*., 2002).

Biochar contains some important plant nutrients which significantly affect crop growth. Maize yield and nutrient uptake were significantly improved with increasing biochar application rate in combination with other commercial fertilizers. Yield characteristics and water use efficiency of maize was increased from 50 to 100% when biochar application rate was increased from 15 to 20 t ha^{-1} (Uzoma *et al*., 2011). Nutrient uptake and crop growth rate was increased with higher biochar applications. Maize yield and yield components showed positive response when biochar was used as soil amendment because it improves the field-saturated hydraulic conductivity of the sandy soil, as a result net WUE also increased and more moisture and nutrients were available to the crop through out the growing season (Steiner, *et al.*, 2007)

Several factors affect maize growth and yield. One of the most important factors is weeds competition with maize crop for available resources. It has been reported as one of the major causes of poor maize yields in cereal based cropping pattern of Pakistan (Ali *et al*., 2011). This competition is most serious and drastically reduce maize yield at initial crop growth stage (Mitchell *et al*., 2005). Under the adequate supply of essential nutrients and soil moisture, successful cultivation of maize depends largely on efficient weed control. Water and fertilizer use efficiency are the two most important inputs for obtaining high yields under irrigation and it is adversely affected by poor weed control (Tolessa and Friesen, 2001). Severe loses in yield up to 70% of maize are reported in smallholder farming (Feldman *et al*., 1998). Although maize producers are facing so many economic problems, one of the major concerns is inadequate weed control. Many researchers concluded that several weeds species could not be effectively controlled although many effective herbicides have been developed in last few years. The present experiment was designed in order to study the effect of various organic and inorganic fertilizers on maize phenology and weeds density.

METHODS AND MATERIALS

An experiment was conducted at New Developmental Farm of The University of Agriculture, Peshawar, Pakistan during 2012. The experiment consisted of biochar application at three levels (0, 25 and 50 tons ha^{-1}), farmyard manure (FYM) at two levels (5 and 10 tons ha^{-1}) and nitrogen (N) at two levels (75 and 150 kg ha^{-1}). Biochar and FYM as required were applied before crop sowing. All the recommended level of phosphorus and half of nitrogen were applied at sowing time and remaining half dose of N was applied at 6 leaves stage in maize. Urea and SSP was used as sources of N and P, respectively.

The experiment with three replications was laid out in randomized complete block design. The plot size of 4.2 m by 4 m with strong bunds around each plot was made to prevent the loss of treatment materials during irrigation. The field was ploughed twice up to the depth of 30 cm with the help of cultivator followed by planking to break the clods and level the field. 'Azam' cultivar of maize was sown at the seed rate of 30 kg ha^{-1} on 25th June, 2012. Recommended irrigation schedule was followed for the experiment, however changes were made according to weather conditions as and when needed.

The details of the treatments were as following:

Treatments	**BC (tons ha^{-1})**	**FYM (tons ha^{-1})**	**N (kg ha^{-1})**
T1	0	0	0
T2	0	5	75
T3	0	5	150
T4	0	10	75
T5	0	10	150
T6	5	5	75
T7	5	5	150
T8	5	10	75
T9	5	10	150
T10	10	5	75
T11	10	5	150
T12	10	10	75
T13	10	10	150

Data were recorded on days to 75% tasseling, silking and physiological maturity and weed density 30 and 60 days after sowing. Data on days to 75% tasseling were recorded as number of days from date of sowing to 75% tassels appeared in each plot. Days to 75% silking were determined by counting number of days from planting to 75% silk emergence in each plot. Date on physiological maturity was recorded for whole experimental units. Complete loss of green color was used as criterion for physiological maturity. Days to maturity were calculated as difference between the date of physiological maturity and date of sowing. Weed density was recorded at 30 and 60 days after sowing (DAS) from randomly selected three sites one meter long from each experimental unit and was averaged to get weeds density m^{-2}. Similarly, Fresh and sun dried biomass of the samples were recorded to get weed fresh and dry weight data.

Statistical analysis

Data collected were analyzed statistically according to the procedure relevant to RCB design. Upon significant F-Test, least significance difference (LSD) test was used for mean comparisons to identify the significance among the treatment means (Jan *et al*., 2009).

RESULTS AND DISCUSSION

Number of days to tasseling

Data regarding number of days to tasseling of maize as affected by Biochar (BC), farmyard manure (FYM) and mineral nitrogen are presented in Table-1. Statistical analysis of the data indicated that different application rates of BC, FYM and N significantly affected number of days to tasseling of maize. However, all the interactions were found non significant, statistically. Application of biochar reduced days to tassel appearance in maize. No BC treated plots took more days to tasseling (54) as compared to BC application at the rate of 50 ton ha^{-1} which took 48 days to tassel formation. Incorporation of FYM at the rate of 50 tons ha^{-1} delayed tasseling process in maize and took 54 days as compared to 5 tons FYM ha^{-1} which took 51 days to tasseling. Similarly, N application at the rate of 150 kg ha^{-1} resulted in higher days to tasseling as compared to 75 kg ha^{-1} N. Similar results are found by Gajri *et al*. (1994) who reported that maize phenological parameters were significantly affected by the amount of N fertilization. Our results are also in line with the findings of Lemcoff and Loomis (1994) who investigated that phenological events like tasseling, silking and maturity in maize were significantly delayed by increasing rate of mineral N than the other sources.

Number of days to silking

Data regarding days to silking of maize are reported in Table-1. Statistical analysis of data showed that BC, FYM and N application rates significantly affected days to silking in maize. Days to silking decreased as BC application rate increased from 0 to 50 tons ha^{-1} and BC application at the rate of 50 tons ha^{-1} took lesser days to silking followed by 25 tons BC application while no BC treated plots resulted in delayed silking. Application of FYM at the rate of 50 tons ha^{-1} took more days to silking as compared to 5 tons ha^{-1} FYM application. Nitrogen application at the rate of 1750 kg ha^{-1} took more days to silking (60) as compared to 75 kg N ha^{-1} (57). Silking formation is the indicator of maize reproductive stage. Silking appearance delayed as N application rate increased from 75 to 150 kg ha^{-1}. It might be attributed to the fact that nitrogen promotes vegetative growth and delays maturity (Ali *et al*., 2011). Delay in silking in FYM treated plots could be attributed to slow and timely release of essential nutrients from FYM throughout the growing season that encourages plant vegetative growth (Ali *et al*., 2011).

Number of days to physiological maturity

Biochar, FYM and N application rates and their combination significantly affected days to physiological maturity of maize. Process of physiological maturity was delayed FYM and N while BC resulted in early maturity. Application of BC at the rate of 50 tons ha^{-1} resulted in early maturity as compared to no biochar treated plots. Incorporation of FYM at the rate of 10 tons ha^{-1} resulted in delayed maturity and took 91 days while in 5 tons ha^{-1} FYM applied plots maturity was observed after 89 days. Mineral N at the rate of 150 kg ha^{-1} took more days to physiological maturity (93 days) as compared to 75 kg N ha^{-1} which took 87 days to physiological maturity. Incorporation of mineral N delayed leaf senescence, sustained leaf photosynthesis during active crop growth stage and extended the duration of vegetative growth (Frederick and Camberato, 1995). Our results are in agreement with the findings of Matsi *et al*. (2003) who reported that slow release of N from FYM could be possible reason for delayed phenology in N treated plots. Similar results were reported by Ali *et al*. (2011) who found that number of days to physiological maturity in maize increased as N application rate increased from 0 to 150 kg ha^{-1}.

Weed density 30 days after sowing (m^{-2})

In Table-2 the effect of various biochar levels, FYM and N application rates on weeds density 30 days after sowing are presented. The treatments significantly affected weed density 30 days after sowing. Planed mean comparison indicated that contrast between control vs. rest and biochar vs. no biochar was significant. Similarly, the BC x N interaction was significant while BC x FYM, N x FYM and BC x N x FYM interactions were non significant. Biochar application significantly reduced weed density 30 days after sowing.

Table-1. Days to tasseling, silking and maturity of maize as affected by biochar, FYM and N application rates

Biochar (tons ha^{-1})	Days to tassling	Days to silking	Days to maturity
0	54.83 a	60 a	93 c
25	53.42 a	57 b	90 b
50	48.83 b	54 c	84 a
L.S.D	1.4	2.74	2.92
FYM (tons ha^{-1})			
5	51	57	89
10	54	59	91
Significance Level	*	*	*
Nitrogen (kg ha^{-1})			
15	50.89	57	87
30	53.83	60	93
Significance Level	*	*	*
Control vs. Rest			
Control	47.67	54	84
Rest	52.36	58	88
Significance Level	0.00	ns	ns
Biochar vs. No biochar			
Biochar	51.63	57	87
No Biochar	53.83	60	90
Significance Level	0.00	ns	ns
Interactions			
BC x N	ns	ns	ns
BC x FYM	ns	ns	ns
N x FYM	ns	ns	ns
BC x N x FYM	ns	ns	ns

Higher weed density was recorded in plots where no BC was applied while lowest weeds were counted in plots treated with 50 tons ha^{-1} BC. Incorporation of FYM and mineral N at the rate of 10 tons ha^{-1} and 175 kg ha^{-1} respectively resulted in higher weeds density as compared to 5 tons ha^{-1} and 75 kg ha^{-1} FYM and N. Possible reason for higher weeds density in organic manure plots may be the manures contain different weeds seeds and thus increased weed seed bank in field. Similar results were reported by Jama *et al*. (1997) who stated that application of organic manures resulted in higher weeds biomass and weeds density. Our results are in line with the findings of Ali *et al*. (2011) who reported that weeds density m^{-2} in maize was higher in FYM incorporated plots as compared to control.

Table-2. Weeds density 30 DAS and 60 DAS as affected by biochar, FYM and N application rates.

Biochar (tons ha^{-1})	Weeds density 30 days after sowing	Weeds density 60 days after sowing
0	139 c	216 b
25	122 b	194 a
50	113 a	198 a
L.S.D	9.85	15.4
FYM (tons ha^{-1})		
5	106	186
10	136	217
Significance Level	**	**
Nitrogen (kg ha^{-1})		
15	110	191
30	131	212
Significance Level	**	**
Control vs. Rest		
Control	80	160
Rest	121	201
Significance Level	**	**
Biochar vs. No biochar		
Biochar	118	199
No Biochar	127	206
Significance Level	**	**
Interactions		
BC x N	Fig 1	Fig 2
BC x FYM	ns	ns
N x FYM	ns	ns
BC x N x FYM	ns	ns

Weeds density 60 days after sowing

Data regarding weeds density m^{-2} in maize 60 days after sowing are reported in Table-2. Analysis of the data showed that BC, FYM and N significantly affected weed density m^{-2} 60 days after sowing in maize. The BC x N interaction was found significant while rest of the interactions were found non significant. Similarly, control vs rest and BC vs No BC contrast were found significant. The two levels of BC (25 and 50 tons ha^{-1}) were not statistically different from each other however both significantly reduced weed density m^{-2} as compared to no BC applied plots. Higher weeds density (216) was recorded in No BC plots while the weed density was lower in 50 tons ha^{-1} BC applied plots. Higher weeds density (217) was recorded in 10 ton ha^{-1} FYM applied plots as compared to 5 ton ha^{-1} (186). Nitrogen application at the rate of 175 kg ha^{-1} resulted in higher weeds density (212) as compared to 75 kg ha^{-1} (160). The superiority of farmyard manure in terms of enhancing weeds population could be explained from the fact that FYM contains indigenous seed bank and also essential nutrients required for rapid weeds growth. Similar results were reported by Ali *et al*. (2011) who found higher weeds density in FYM and N amended plots.

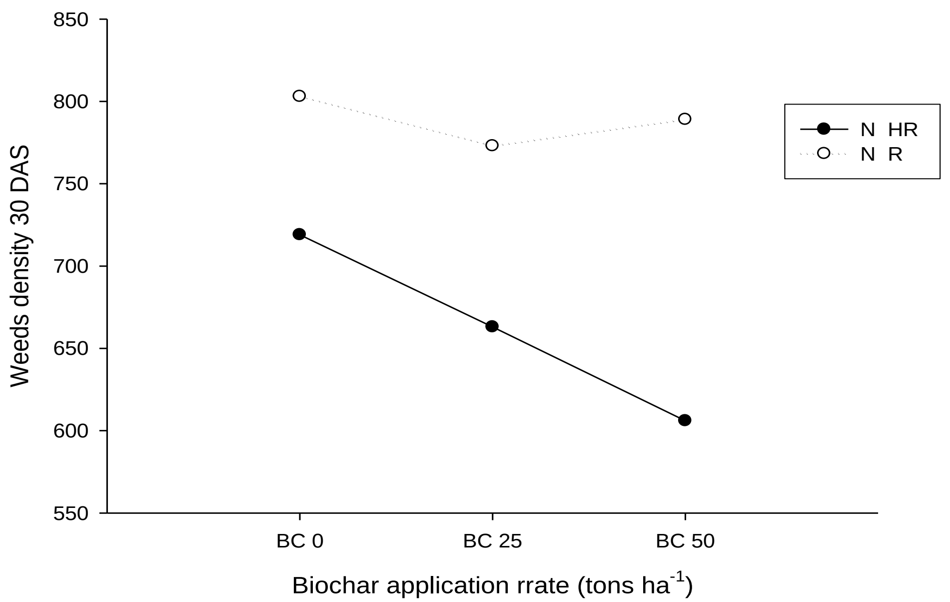

Figure 1. BC x N interaction for weeds density 30 DAS.

CONCLUSIONS

From the findings of the study it is concluded that biochar application at the rate of 50 tons ha^{-1} resulted in delayed phenology and lower weeds density. Similarly, FYM and N application at the rate of 5 tons ha^{-1} and 75 kg N ha^{-1}, respectively reduced number of weeds m^{-2} in 30 DAS and 60 DAS.

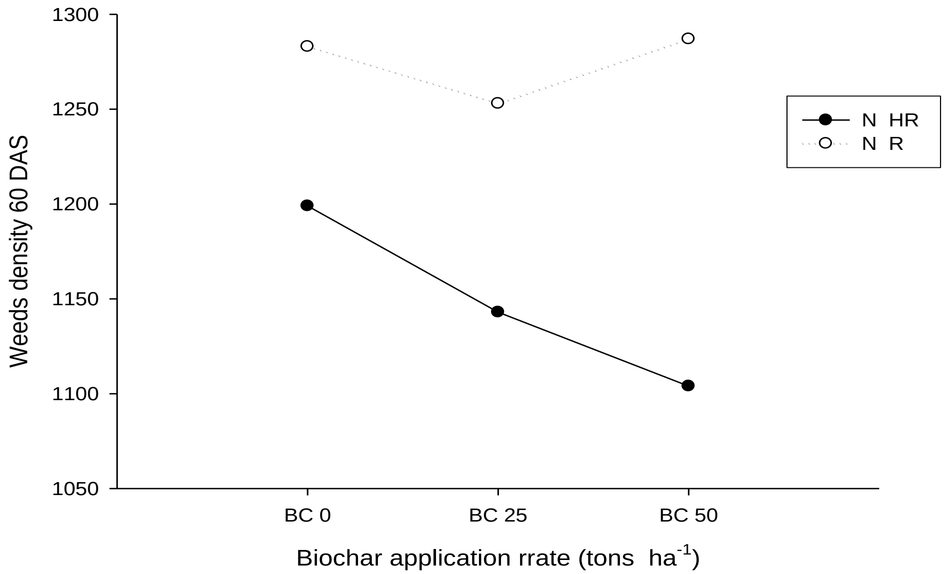

Figure 2. BC x N interaction for weeds density 60 DAS.

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