ISSN:0971-1260
Vol-22-Issue-16-August-2019

Influence of Fly Ash And Organic Amendments on Yield Attributes of Maize (*Zea Mays* L.) Under Punjab Agro Climatic Condition

Kawaljeet Kaur ǂ, Premasis Sukul*

Department of Soil Science and Agriculture Chemistry, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India.

*Corresponding author: Email i.d.: premasis.20644@lpu.co.in

Mobile: 7044287797

ǂ Present address: School of Agriculture, CT Group of Institution Shahpur campus, Jalandhar, Punjab, India

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ABSTRACT

A field experiment was conducted to determine effect of fly ash with organic and inorganic amendments on yield attributes of maize crop under Punjab agro-climatic condition during kharif season of 2018 in Randomized Block Design (RBD) with three replications and eight treatments. The source of nutrients applied were various combinations of poultry manure (PM), Fly ash(FA) and recommended dose of fertilizer(RDF). Result revealed that all the treatments showed positive influence over control with respect to number of cobs/plant, cob length, number of grains/cob, 100 grains weight (g), grain yield and straw yield (t/ha), harvest index (%), and economical view. However, the application of RDF + PM(T_2 100% RDF + 100% PM) was found to exert best results, followed by (T_3 10% FA + 90% RDF + 90% PM).

Keywords: - Fly ash, poultry manure, inorganic fertilizers, maize, yield attributes, benefit-cost ratio

ISSN:0971-1260
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INTRODUCTION

Maize ranks third among important cereals in the world and is next to rice and wheat. Being a C_4 plant, it is highly capable of using solar energy to convert atmospheric carbon dioxide into dry matter. It is primarily used for consumption by both humans and animals (Keba and Sori, 2013), apart from its industrial uses.Maize is widely used in starch,alcohol, syrup, oil, flaking, gluten, lactic acid or acetone production in different textiles, fermentation and food industries. The United States has the largest area among the maize - growing countries, followed by Brazil, China, Mexico and India. In India, maize in 1.15 Mha area accounts for nearly 15.5 Mt of production (Hareesh*et al*., 2016). It is presumed that maize demand will be doubled within the growing world by 2050 (Roségrant*et al*., 2009).

Fly ash (FA) is a by-product of carbon combustion in thermal power stations on using coal as a raw material for energy generation. In developing countries, the major problem is the disposal of large quantities of FA. In general, FA is disposed of in basins or deposits and only a small quantity of ash (less than 3% of the total ash production) is used commercially in the construction, cement and road construction industries in a country like India (Kumar and Jha, 2014). However, there are opportunities remained to use FA for favorable economic purposes in agriculture because it contains considerable amount of various minerals and is considered as a rich source of almost all essential plant nutrients (Porbaha*et al*., 2000; Vittal 2001, Kaur *et al.*, 2019). Soil physico-chemical properties are influenced favorably by FA application in soil (Panda and Biswal, 2018).Usage of FA in agriculture may also provide a feasible alternative for its safe disposal without critical deleterious outcomes (Kaur *et al.*, 2019). FA is administered in soil in combination with inorganic fertilizers, organic manures such as FYM, poultry manure, vermicompost, sewage sludge, and microbial cultures to improve crop growth and yield (Singh and Sukul, 2019). Poultry manure (PM) provides a significant source of N, P, K and trace elements for crop production and is very effective in improving physical, chemical and biological characteristics of soil. PM contains higher nitrogen and phosphorus compared to other organic manures. Therefore, in the present investigation an attempt has been made to evaluate the best possible combination of organic manure, inorganic fertilizers and fly ash in achieving improvements in yield parameters for maize under Punjab agro-climatic conditions along with safe disposal of fly ash.

MATERIALS AND METHODS

A field experiment with maize crop (variety Kanchan 25) was conducted in the farm of Lovely Professional University during *Kharif* season 2018-2019 with various combinations of inorganic fertilizers, PM and FA, using eight treatments withthree replications for each treatment. The size of the experimental plot of each treatment and each replication was 5 m × 4 m with plant to plant and row to row distance of 60 cm and 20 cm, respectively. Recommended dose of fertilizers (RDF) for N, P and K were 180, 60 and 40kg/ha, respectively, while both PM and FA were applied to the field @20 t/ha. The experiment was laid out in RBD design. The treatments were as follows: T_0 control in which no use of FA, manure and RDF, T_1 (100% RDF), T_2 (100% RDF + 100% PM), T_3 (10% FA + 90% RDF + 90% PM), T_4 (20% FA + 80% RDF + 80% PM), T_5 (30% FA + 70% RDF + 70% PM), T_6 (40% FA + 60% RDF + 60% PM), T_7 (50% FA + 50% RDF + 50% PM). Number of cobs/plant, cob length, number of grains/cob, 100 grains weight (g), grain and straw yield (t/ha), harvest index (%), and overall benefit-cost ratio were studied critically to evaluate the influence of various soil organic and inorganic amendments in their different combinations.The harvest index was calculated by dividing the yield of grain (economic yield) with the biological yield (grain + straw) according to the following formula (Singh and Stoskopf, 1971).

Harvest Index (%) = Economic yield (kg/ha) × 100/Biological yield (kg/ha)

Benefit-cost ratio was calculated by using the formula:
B: C= Gross return/cost of cultivation

Statistical analysis

OPSTAT software, developed by CCS HAU, Hisar, India,was applied to identify the most efficient treatment. Anova was made to examine the test of significance of difference for each parameter.

RESULTS AND DISCUSSION

Number of cobs/plant

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Effect of FA and PM with different levels of RDF in T_2, T_3 and T_4 on number of cobs/plant were found significant as compared to control and other treatments (Table 1). Effects of different combinations of FA, PM and RDF were found at par in T_0, T_1,T_5, T_6 and T_7. They all produced only one cob per plant. However, mean value of number of cobs/ per plant in T_2, T_3 and T_4 were 1.33, 1.23 and 1.13, respectively. It proves that complementary use of organic and inorganic fertilizer in a definite proportion provided better result due to better nutrient uptake and development of the plant and cob, which are in well agreement with previous studies (Farhad*et al.*, 2009; Uwah*et al.*, 2011; Ekesiobi*et al*., 2015).

Length of cob

The mean cob length was found to be in the range of 10.3-12.7 cm (Table 1). Maximum cob length was obtained in T_2 (12.8 cm) followed by T_3 (12.3 cm), T_4 (11.9 cm), T_5 (11.5 cm), T_1 (11.2 cm), T_6 (11.0 cm), T_7 (10.6 cm) and T_0 (10.3 cm). Except T_7, all treatments showed significant increase in cob length over control. However, maximum treatment effects were found with the application of 100% RDF + 100% PM (T_2). In general, application of organic manure along with inorganic fertilizers exhibits better result due to improved soil properties and nutrient uptake by plants (Bahrani*et al*., 2007; Mohamed *et al*., 2008; Ndukwe*et al*., 2014). FA also improves soil physico-chemical properties (Singh *et al*., 2011; Sheoran*et al.*, 2014) which in turn influence growth and yield attributing characters of crops.

Number of grains/cob

Number of grains/cob is also an important factor influencing crop yield which is dependent upon the cultural practices and nutrient applied from various sources.Considering all the treatments, application of 100% RDF + 100% PM (T_2) recorded maximum number of grains/cob, increase over control. The number of grains/cob ranged from 199.7 – 279.0. Maximum number of grains/cob was obtained in T_2 (279.0) followed by T_3 (272.3), T_4 (266.9), T_5 (259.4), T_1 (235.5), T_6 (229.0), T_7 (214.4) and T_0 (199.8)(Table 1). The present results showed that application of PM exhibited significant effect on number of grains/cob when it was combined with chemical fertilizer, which conform earlier findings (Farhad*et al., 2009;* Uwah*et al.,* 2011; Adamu*et al.*, 2012*;* Verma *et al., 2018)*

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Table 1 Effect of FA, PM and inorganic fertilizers on maize number of cobs/plant, cob length and number of grains/cob

Treatments	Number of Cobs/plant	Length of cob (cm)	Number of grains/cob
T_0	1.00	10.3	199.8
T_1	1.00	11.2	235.5
T_2	1.33	12.8	279.0
T_3	1.23	12.3	272.3
T_4	1.13	11.9	266.9
T_5	1.00	11.5	259.4
T_6	1.00	11.0	229.0
T_7	1.00	10.6	214.5
C.D.	0.082	0.642	4.6
SE(m)	0.027	0.21	1.502
SE(d)	0.038	0.296	2.124
C.V.	4.257	3.173	1.064

100 grains weight (g)

The data related to test weight (g) influenced by application of FA, PM with different levels of RDF are depicted in Table 2. Application of FA and PM with different levels of inorganic fertilizers caused a significant variation in test weight of maize grains. The effects were found statistically significant over control (T_0), T_2 and T_3 exhibited maximum effect and increase in FA concentration decreased the effect significantly. The maximum test weight was recorded in T_2 (32.5 g) followed by T_3 (31.0 g), T_4 (28.8 g), T_5 (27.6 g), T_1 (25.5g), T_6 (23.5 g), T_7 (22.3 g) and T_0 (21.0 g). It also revealed that PM combined with RDF was excellent source for fertilization than inorganic fertilizers alone. Previous studies (Abbas *et al.*, 2012; Shah *et al.,* 2017) also conform our findings.

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Grainand straw yield (t/ha)

Data pertaining to grain and straw yield (t/ha) of maize as influenced by the application of FA, PM and RDF are presented in Table 2. Yield attributing characters are directly related with economic yield of plant. The grain yield of maize is a product of photosynthetic process which occurs in the leaves. The factors which contribute to the yield are nutrient availability, moisture, soil pH, temperature and many others. Low availability of the resources causes low grain yield. All treatments were found to increase grain yield over control. However, T_2 treatment performed best. Significantly higher grain yield (4.44 t/ha) was obtained with the application of 100% RDF + 100% PM (T_2)followed by T_3 (3.85 t/ha), T_4 (3.44 t/ha), T_5 (3.06 t/ha), T_1 (2.69 t/ha), T_6 (2.60 t/ha), T_7 (2.36 t/ha) and T_0 (1.78 t/ha). Increased number of grains/ cobas evidenced in the present study (Table 1) led to increased grain yield at maturity. The increase in grain yield under treatments involving organic/inorganic soil amendments might be due to the improvement in soil physico-chemical properties, optimum availability of plant nutrient to the crop and high photosynthetic activities of plants (Hasanuzzaman*et al*., 2010; Uwah*et al.,* 2011;Adamu*et al*., 2012; Shah *et al.,* 2017).

Straw yield was significantly influenced by using FA and PM with distinctive ranges of RDF. Significantly higher straw yield (5.11 t/ha) was obtained with the application of 100% RDF + 100% PM whereas, lower straw yield was observed in control (2.81 t/ha). An increasing trend in straw yield was found to be in the order of T_2 (5.11 t/ha) > T_3 (4.55 t/ha)> T_4 (4.13 t/ha)> T_5 (3.94 t/ha) = T_1 (3.71 t/ha) = T_6 (3.64 t/ha) = T_7 (3.61 t/ha) = T_0 (2.81 t/ha), emphasizing a significantly higher straw yield in T_2followed by T_3 and T_4, and other treatments showed no significant difference within themselves. Treatment effects within T_0, T_1, T_5, T_6 and T_7 were found to be at par. PM as such contains high organic matter. It enhances soil organic matter content in addition to the improvement of other physico-chemical and biological properties of soil (Adeoye *et al*., 2011; Ogunlade*et al*., 2011). Therefore, combined use of PM and RDF should obviously exert better result as it was reflected in this study. Similar results were also found in earlier studies (Yadav and Lourduraj, 2006; Raikar*et al*., 2009; Ekesiobi*et al*., 2015). It is interesting to mention that addition of FA with reducing RDF and PM incorporation in soil as evidenced by T_3 (10% FA + 90% RDF + 90% PM) and T4 (20% FA + 80% RDF + 80% PM) were also found to increase the straw yield. However, higher concentration of FA

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decreased straw yield. This observation confirms the positive influence of FA at lower concentration than higher one on plant growth and yield attributes (Panda and Singh, 2010; Sarkar *et al*., 2013; Panda *et al.*, 2015). Combination of FA, PM and inorganic fertilizers supplied the nutrient elements necessary to promote more vigorous growth, improved meristematic and physiological activities in the plants, as well as improved the soil properties; thereby resulting in the synthesis of increased photo-assimilates that enhanced yield ability (Akongwubel*et al*., 2012; Ekesiobi*et al.*, 2015)

Treatments	Test weight of 100 grains (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
T_0	21.0	1.79	2.81	38.46
T_1	25.5	2.69	3.71	41.83
T_2	32.5	4.44	5.11	46.47
T_3	31.0	3.85	4.55	45.84
T_4	28.8	3.44	4.13	45.44
T_5	27.6	3.06	3.94	43.57
T_6	23.5	2.60	3.64	41.42
T_7	22.3	2.36	3.61	39.36
C.D.	1.825	0.339	0.369	4.846
SE(m)	0.596	0.111	0.121	1.582
SE(d)	0.843	0.157	0.171	2.238
C.V.	3.892	6.332	5.306	6.403

Table 2. Effect of FA, PM and inorganic fertilizers on maize Grain and straw yield (t/ha)

Harvest Index (%)

The application of FA, PM and inorganic fertilizers significantly influenced the harvest index (HI) of maize. All treatments showed more HI over control and the effects were found statistically significant, except T_7 (Table 2). Although T7 showed more HI than control (T_0), but

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the effects were statistically insignificant. Maximum HI was recorded in T_2 (46.47 %), followed by T_3 (45.84 %), T_4 (45.44 %), T_5 (43.57 %), T_1 (41.83 %), T_6 (41.42 %), T_7 (39.35 %), and T_0 (38.82 %). The maximum HI detected in T_2 might be attributed to the complementary use of inorganic and organic fertilizers, which improved the physico-chemical properties of the soil and thus, increased nutrient status in the soil, and nutrient uptake by the plants at desired level. MoreHI represents more grain yield. In the present investigation combined effect of PM and RDF was found to produce more HI as compared to sole application of RDF. The results are well in agreement with previous studies (Hasanuzzaman*et al*., 2010; Uwah*et al*., 2011).

Economical aspect related to benefit-cost ratio

The application of FA, PM and inorganic fertilizers, influenced the benefit-cost ratio during maize cultivation. Due to the difference in the cost of fertilizers and manures, the cost of cultivation varied among all the treatments. The maximum cost of cultivation was recorded in the T_7 (Rs.57526 /ha) over control T_0 (43328 Rs. /ha) (Table 3). The highest gross return from maize cultivation was observed in the treatment T_2 (Rs.111082 /ha) and lowest gross return was found in T_0 (Rs.43832 /ha). Treatment T_2 (100% RDF + 100% PM) provided maximum net return (Rs. 53958 /ha) followed by T_3 (Rs.39128 /ha), T_4 (Rs.28716 /ha), T_5 (Rs.19217 /ha), T_1 (Rs.17708 /ha), T_6 (Rs.7472 /ha), T_7 (Rs.1474 /ha) over control T_0 (Rs.504/ha). Maximum benefit cost ratio of 1.94 was found in T_2 (100% RDF + 100% PM) as compared to control T_0 (1.01). The increasing trend in benefit cost ratio was found to be in the order of $T_2>T_3>T_4>T_1>T_5>T_6>T_7>T_0$. Thus, application of PM along with chemical fertilizer might provide maximum benefit-cost ratio, which isin conformity with previous findings of Hasanuzzaman*et al.* (2010**).**

Table 3. Economical aspect of Maize of cultivation

Treatments	**Yield (t/ha)**	**cost of cultivation (Rs./ha)**	**Gross return (Rs./ha)**	**Net return (Rs./ha)**	**B:C ratio**
T0	1.78	43328	43832.5	504.5	1.01
T1	2.69	49624	67332.5	17708.5	1.36
T2	4.44	57124	111082.5	53958.5	1.94
T3	3.85	57204	96332.5	39128.5	1.68

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T4	3.44	57284	86000.0	28716.0	1.50
T5	3.06	57365	76582.5	19217.5	1.34
T6	2.60	57445	64917.5	7472.5	1.13
T7	2.36	57526	59000.0	1474.0	1.03

CONCLUSION

The present study revealed that maize yield was significantly enhanced by application of complementary dose of organic and inorganic fertilizers (100% RDF + 100% PM). Application of FA to maize field contributed an average role in growth and development, and in turn overall yield. Application of lower dose of FA proved to be better than higher dose. Considering the harvest index, replacement of organic and inorganic fertilizers (10% each) by FA (10%) provides same results as evidenced by the treatment involving 100% PM and 100% inorganic fertilizers. Therefore, application of FA at low dose in combination with organic and inorganic fertilizers may promote maize yield, apart from the partial solution of FA disposal problem.

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