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PROFITABILITY OF THREE MAIZE HYBRIDS AS INFLUENCED BY VARYING PLANT DENSITY AND POTASSIUM APPLICATION

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ABSTRACT

High plant density brings bareness in plants. Potassium (K) application is one of the solutions of this plant bareness. To explore profit of different maize hybrids under varying plant density levels, to minimize plant bareness by application of K, an experiment was laid out in randomized complete block design with split plot arrangement, randomizing maize hybrids in main plots (H_1= Pioneer-3012, H_2= Pioneer-3062, H_3= Pioneer – 30D55) and plant density levels (P_1 = 15 cm x 70 cm (95238 plants ha^{-1}), P_2 = 25 cm x 70 cm (57142 plants ha^{-1}), and P_3 = 35 cm x 70 cm (40816 plants ha^{-1}) with K application (K_0=0, K_1=100, K_2=150, K_3=200 and K_4=250 Kg ha^{-1}) in subplots with four replications. It was observed that among all maize hybrids, Pioneer-30D55 produced maximum net income (Rs.92877.88 ha^{-1}) at plant density level of 95238 plants ha^{-1} with the highest cost benefit ratio (2.78). Similarly, by K application grain production increased with the increase in K application. Pioneer-30D55 produced maximum grain yield (6.41 t ha^{-1}) when K was applied @ 200 Kg ha^{-1} but when it was calculated economically it was found non profitable. The highest cost benefit ratio (2.71) was noted in control where no potassium was applied. It is therefore suggested that among all three maize hybrids, Pioneer-30D55 should be preferably grown at high plant density (95238 plants ha^{-1}) with zero K application to achieve maximum profit. The reason was that high input cost of K did not respond grain yield in the same reciprocal fashion as desired.

Key words: Maize hybrids, plant density, K application, plant bareness, profitability.

INTRODUCTION

Maize *(Zea mays* L.*)* is an important food and feed crop of the world and is often referred as “the king of grain crops”. It ranks third in world production after wheat and rice and is important cereal crop of Pakistan (Akhtar *et al*., 1999). It forms major dietary part of the millions of the people in the form of bread, cake and porridge in many parts of the world Asia, Africa and America. Besides being an important food grain for human consumption, maize has also become a major component of livestock and poultry feed (Bukhsh, 2010).

In recent years a large quantity of corn has been used in the manufacturing of shortening compounds, soaps, ammunition, varnishes, paints and similar other products (Muhammad and Khattak, 2009), whereas the by-product seed cake is a valuable component of livestock feed (Bukhsh *et al*., 2010; Mehboob *et al*., 2008). Maize oil is used in cooking, bakery products, oleomargarine, salad dressing and pharmaceutical. Maize starch is used for making plastics, cellophane, photographic films, dying of clothes, manufacturing of paper, paper boards and tanning of the hides. It is also utilized for getting the important industrial by-products such as glucose, flakes, custard, jelly and energile etc. (Khan *et al*., 1999).

Normally, higher yield in different maize hybrids is obtained simply by increasing the plant density (PD) to increase grain yield. Increase in grain yield mean more profit, but it is not so simple that by increasing PD would multiply the grain yield through many folds (Ahmad *et al*., 2001; Bukhsh, 2010). There is a certain limit where increase in PD tends to stabilize the grain and biological yield and it tends to decline (Ekasingh *et al*., 2004).

There is diverse variety of maize hybrids available in Pakistan for getting bumper yield. However, the potential of every hybrid varies when PD is increased per unit area, as this phenomenon tends to develop the abnormality of delayed silking in maize hybrids as compared to tasseling (Ranaweera *et al*., 2002), which causes a lot of shedding of pollen grains without fertilizing the ovules (grains) in the ovary (cob). This abnormality in its intensity varies from hybrid to hybrid because of its genetic potential (Bukhsh, 2010). The hybrids having tolerance to high PD do not exhibit this abnormality, while poor in tolerance to high PD exhibit this abnormality. This abnormality has been recognized as plant bareness (Witt and Pasquin, 2007).

One of the possible solutions for the amelioration of plant bareness has been suggested as application of potassium (Singh and Choudhry, 2008). Potassium (K), one of three primary nutrients, is absorbed by plants in larger quantities than any other element;

expect N (Krauss, 1997). K plays a vital role as macronutrient in plant growth and sustainable crop production (Marschner, 1986). It maintains turgor pressure of cell which is essential for cell expansion. It helps in osmo-regulation of plant cell, assists in opening and closing of stomata (Mengel and Kirkby, 1987). It plays a key role in activation of more than 60 enzymes (Tisdale *et al.*, 1990). Its application has primitive effect on growth and development (Brar and Singh, 1995) and grain yield in maize (Davis *et al.*, 1996). Modern maize cultivars respond to K application differently due to difference in its uptake, translocation, accumulation, growth and utilization (Jiagui *et al*., 2004). K application tends to ameliorate the plant bareness by reducing the difference of silking (Mahmood *et al*., 2000) and tasseling period (Rasheed *et al*., 2004). Final results are seen in the form of grain yield. But the question again arises that how much quantity of K should be applied for this purpose (Lloveras *et al*., 2001) and whether it would be a profitable practice for the farmers or not (Hiesey and Mwangi, 1996; Iqbal, 1998).

Keeping in view the above facts it was imperative to design a study of such type to investigate the profitability of different maize hybrids under high PD and K application.

MATERIALS AND METHODS

The experiment was conducted on a sandy clay loam soil at Government Agricultural Extension Farm, Model Town – A, Bahawalpur. The climate of the region is semi-arid and subtropical. The experimental area is located at 30°.12' North, 71'.26' East and at an altitude of 120 meters above sea level. As soil of the experimental area was quite uniform, a composite and representative soil sample to a depth of 30 cm was obtained with soil auger, prior to sowing of the crop. Percentage of sand, silt and clay was determined by Bouyoucos hydrometer method using one percent sodium hexametaphosphate as a dispersing agent. Textural class was determined by using the international textural triangle (Moodie *et al.*, 1959). Soil was analyzed for its various chemical properties by using the methods as described by Homer and Pratt (1961). The soil was analyzed for N and K. The soil was sandy clay loam containing 65% sand, 15% silt and 20% clay. Its chemical characteristics included saturation 36%, pH 7.9, EC_e 1.3 dS m^{-1}, organic matter 0.83%, total nitrogen 0.083%, available phosphorous 1 ppm and available K 125 ppm.

The experiment was laid out in randomized complete block design with split plot arrangement, randomizing maize hybrids in main plots (H_1= Pioneer-3012, H_2= Pioneer-3062, H_3= Pioneer – 30D55) and plant density levels (P_1 = 15 cm x 70 cm (95238 plants ha^{-1}), P_2 = 25 cm x 70 cm (57142 plants ha^{-1}), and P_3 = 35 cm x 70 cm (40816 plants ha^{-1}) with K application (K_0=0, K_1=100, K_2=150, K_3=200 and K_4=250 Kg ha^{-1}) in subplots with four replications. The net plot size measured 3.5m x 7m.

Before seed bed preparation, presoaking irrigation of 10 cm was applied. When soil reached at proper moisture level locally called as "*Wattar*" condition, the seed bed was prepared by giving four cultivations with a tractor mounted cultivator. Each time soil was cultivated to a depth of 8-10 cm. Planking was given, after every two times cultivations. The crop was planted on August 3, 2005 and August 7, 2006. The seed was drilled with the help of single row-hand drill using seed rate 30 kg ha^{-1}. However, different levels of PD were maintained by thinning the crop when it reached at 45 cm height. The NP was applied @ 300, 200 kg ha^{-1}, respectively. Urea, diammonium phosphate and sulphate of potash were used as sources of N, P and K fertilizers, respectively. All potash and phosphatic and half dose of N fertilizer was applied at the time of sowing, while the remaining N was top dressed at first irrigation stage of the crop. In addition to rainfall received during the growing period of the crop, six irrigations were applied as and when needed at different plant developmental stages till the physiological maturity of the crop. Every irrigation turn was of 7.5 cm. The first irrigation was given ten days after sowing (DAS).

The crop was kept free of weeds by hoeing twice and hand weeding to avoid weed crop competition. Sunfuran was applied @ 20 kg ha^{-1} with second irrigation against stem borer control. Crop was harvested manually on November 11, 2005 and November 16, 2006. After harvesting, the plants were left in the field for two days and thereafter, tied into bundles and stalked for 4 weeks. Then the cobs were separated from the stalk and allowed to dry in sunshine for a few days before threshing. All the meteorological data taken during 2005 and 2006 have been depicted in Fig. 1.

An economic analysis was carried out on the basis of variable and prevailing market prices of K fertilizers and maize grain yield. Net income was calculated by subtracting the total variable cost from the total benefits from each treatment combination. Benefit cost ratio (BCR) was calculated by dividing the gross income by total expenditure. The pooled data was analyzed by using the methodology described in CIMMYT (1988) to measure the level of profitability among different maize hybrids under varying PD and K application levels.

The data were analyzed by the "Mstat" statistical package on a computer (Freed and Eisensmith, 1986). When a significant "F" value was obtained for treatment effect, least significant differences (LSD) test at 0.05 P was applied to determine the significance of the treatment means (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Both the maize hybrids and PD levels had significant effect on NI (Net Income). The NI was significantly varied under different maize hybrids (Table 1). Pioneer-30D55 significantly produced greater NI (Rs. 68000.25 ha^{-1}) than Pioneer-3062 and Pioneer-3012, also statistically differed from each other and produced NI of Rs. 73180.67 ha^{-1} and Rs. 80629.75 ha^{-1}, respectively with significant variation between them. These results are in conformity with the findings of Bukhsh (2010), Ekasingh *et al*. (2004), and Ranaweera *et al*. (2002), who reported that maize hybrids differed in their genetic potential for yield which ultimately affected the NI.

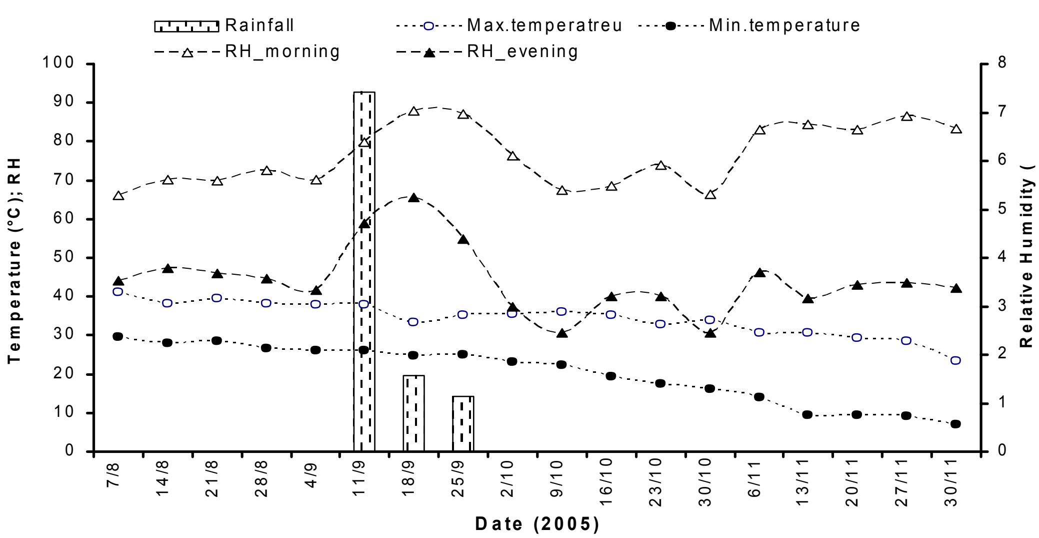
Various PD levels exhibited significant variation among themselves in respect of NI. Crop planted at PD 95238 plants ha^{-1} increased significantly the NI (Rs. 85831.92 ha^{-1}) than rest of the two other PD levels, which also statistically differed from each other and produced NI of Rs.73571.42 ha^{-1} and Rs. 62407.33 ha^{-1}, respectively. Interactive effects of maize hybrids and PD on NI were, however, non significant. These results are in conformity with the findings of the Shah *et al.* (2000), and Singh and Choudhary (2008), who reported that increase in PD increased grain and stover yield which ultimately increased NI.

It is also evident from table 2 that among all three maize hybrids, Pioneer-30D55 produced maximum grain yield with the highest cost benefit ratio (CBR) of 2.78 at PD 95238 plants ha^{-1}. As the cost of seed for sowing is same for all the hybrids and crowding level is achievable as desired .So, it is suggested that Pioneer-30D55 should be preferably grown at PD of 95238 plants ha^{-1} to harvest maximum profit.

Both the maize hybrids and K application levels had significant effect on NI. The NI significantly varied for maize hybrids (Table 3). Although Pioneer-30D55 significantly produced greater NI (Rs. 75479.01 ha^{-1}) than Pioneer-3012 (Rs. 66303.38 ha^{-1}), yet it was at par with Pioneer-3062 (Rs. 71307.14 ha^{-1}). These results are in conformity with the findings of Ahmad *et al*. (2001), Bukhsh (2010), Bukhsh *et al*. (2010), Ekasingh *et al*. (2004) and Ranaweera *et al*. (2002), who reported that maize hybrids differed in their genetic potential for yield which ultimately affected the NI. All the K application treatments decreased NI significantly over control. Maximum NI (Rs. 73373.33 ha^{-1}) was observed in control, which significantly differed with NI (Rs. 70587.39 ha^{-1}), where 100 kg K ha^{-1} was applied, where as minimum NI was recorded (Rs. 67874.00 ha^{-1}), where 250 kg K ha^{-1} was applied. Although maximum grain yield was recorded when 200 Kg K ha^{-1} was applied, yet economically it was in loss. Interactive effects of maize hybrids and K levels on NI were, however, non-significant.

These results are in conformity with the findings of Jiagui *et al*. (2004), Mahmood *et al*. (2000), Rasheed *et al*. (2004), Singh and Choudhary (2008), and Witt and Pasquin (2007) who reported that K application, depend upon previous soil K status, desired grain yield, and cost of K fertilizer. No doubt, K application up to a certain level gave maximum yield and exceeding this dose had a suppressive effect on growth, yield and other related parameters, in addition to this, it became unprofitable (Iqbal, 1998; Lloveras *et al.,* 2001) and its application needed subsidy (Heisey and Mwangi, 1996).

It is also obvious from table 4 that among all the three maize hybrids, Pioneer-30D55 produced the highest cost benefit ratio (2.71), when no K was applied. Application of K tends to decrease cost benefit ratio with the increase in dose of K application. It means application of K is not a profitable practice to reduce plant bareness produced due to crowing stress. The reason was that high input cost of K did not respond grain yield in the same reciprocal fashion as desired.



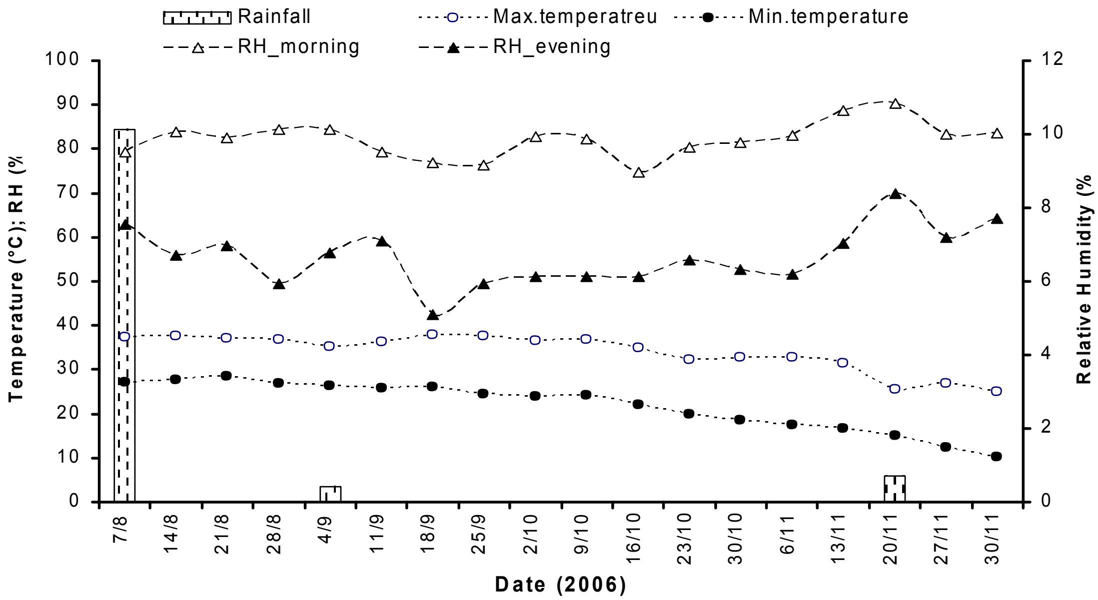


Fig. 1

Meteorological data recorded during 2005 and 2006.

Table 1: Net Income (Rs. ha^{-1}) of three maize hybrids as influenced by varying plant density

Treatments	Means of two years
A- Hybrids (H)	
H_1:Pioneer 3012	68000.25 c
H_2:Pioneer 3062	73180.67 b
H_3:Pioneer 30D55	80629.75 a
LSD=0.05	5097.00*
B- Plant Density (PD)	
P_1: 15 cm x 70 cm (95238 plants ha^{-1})	85831.92 a
P_2: 25 cm x 70 cm (57142 plants ha^{-1})	73571.42 b
P_3: 35 cm x 70 cm (40816 plants ha^{-1})	62407.33 c
LSD=0.05	6459.00*
C- Interaction (H x PD) N.S	
CV=%	9.21

Means followed by different letters in columns are significantly different at P=0.05 *=Significant N.S= Non significant

Table 2: Net Return and Benefit Cost Ratio of maize hybrids as influenced by varying plant density (Mean of two years)

Treatments		Grain Yield (t ha^{-1})	Stover Yield (t ha^{-1})	Gross Income (Rs. ha^{-1})	Total Expenditure (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	CBR
Hybrids	PD ha^{-1}						
Pioneer-3012	95238	6.23	12.51	133917.0	54655	79262	2.60
	57142	5.71	10.59	122183.9	54655	67528.91	2.10
	40816	5.23	9.71	111864.4	54655	57209.38	2.17
Pioneer-3062	95238	6.51	13.08	140010.3	54655	85355.28	2.48
	57142	5.95	11.03	127294.1	54655	72639.13	2.26
	40816	5.43	10.10	116202.2	54655	61547.19	2.26
Pioneer-30D55	95238	6.86	13.87	147532.9	54655	92877.88	**2.78**
	57142	6.32	11.70	135200.6	54655	80545.63	2.62
	40816	5.75	10.72	123120.4	54655	68465.38	2.12

Maize grain cost= Rs. 20000 ton^{-1}, Stover cost = Rs. 750 ton^{-1}

Table 3: Net Income (Rs. ha^{-1}) of three maize hybrids as influenced by varying potassium application

Treatments		Mean of two years
A-Hybrids (H)		
H_1:Pioneer 3012		66303.38 b
H_2:Pioneer 3062		71307.14 a
H_3:Pioneer 30D55		75479.01 a
LSD=0.05		4523.12*
B- K levels (kg ha^{-1})		
K_0=0		73373.33 a
K_1=100		70587.39 b
K_2=150		71269.32 b
K_3=200		72045.17 b
K_4=250		67874.00 c
LSD=0.05		2486.53*
	C- Interaction (H x K)	N.S
C.V (%)		9.95

Means followed by different letters in columns are significantly different at P=0.05 *=Significant N.S= Non significant

Table 4: Net Return and Benefit Cost Ratio of three maize hybrids as influenced by varying K application (Mean of two years)

Treatments		Grain Yield (t ha^{-1})	Stover Yield (t ha^{-1})	Gross Income (Rs. ha^{-1})	Total Expenditure (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	CBR
Hybrids	K application (Kg ha^{-1})						
Pioneer-3012	0	5.37	11.09	115751.5	47079	68672.48	2.66
	100	5.58	11.67	120352.1	54455	65897.05	2.14
	150	5.78	12.23	124705.4	58129	66576.36	2.19
	200	5.97	12.77	129050.8	61781	67269.78	2.12
	250	5.95	12.73	128556.2	65455	63101.22	2.01
Pioneer-3062	0	5.60	11.62	120775.7	47079	73696.73	2.39
	100	5.81	12.18	125360.5	54455	70905.55	2.19
	150	6.01	12.73	129713.8	58129	71584.85	2.30
	200	6.20	13.26	134043.5	61781	72262.53	2.21
	250	6.18	13.20	133541.1	65455	68086.1	2.08
Pioneer-30D55	0	5.80	11.78	124829.8	47079	77750.78	**2.71**
	100	6.01	12.33	129414.6	54455	74959.6	2.18
	150	6.20	12.90	133775.8	58129	75646.78	2.12
	200	6.41	13.49	138384.2	61781	76603.23	2.08
	250	6.39	13.45	137889.7	65455	72434.68	2.13

Maize grain cost= Rs. 20000 ton^{-1}, Stover cost = Rs. 750 ton^{-1}

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