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INFLUENCE OF MULCHING, LIMING AND FARM YARD MANURES ON PRODUCTION POTENTIAL, ECONOMICS AND QUALITY OF MAIZE (*ZEA MAYS* L.) UNDER RAINFED CONDITION OF EASTERN HIMALAYA

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Key words: Farm yard manures, Grain yield, Maize, Net return, Straw mulch

Abstract

A field experiment was conducted to study the effect of mulching, liming and farm yard manures on productivity and quality of maize on a sandy loam soil at Agricultural Research Farm of ICAR RC NEH Region Nagaland Centre, Jharnapani, Medziphema during two consecutive *rabi* seasons of 2010-12 under the rainfed conditions of Eastern Himalaya. Treatment comprised of two mulches (without mulch and straw mulch) in main plot, four levels of lime (control, 0.2, 0.4 and 0.6 t/ha) in sub plot and three levels of farm yard manures (4, 8 and 12 t/ha) in sub-sub plot and replicated thrice in split-split plot design. The significant improvement in yield attributes (cob length, number of rows/cob, number of grain/row, number of grain/cob and 1000-grain weight), yields (grain, stover and biological), economics (gross, net returns and benefit: cost ratio) and quality attributes (carbohydrate, starch and sugar) of maize were recorded in straw mulched plot over no mulch in both the years. The straw mulching recorded 15.9 and 16.5% increase in grain yield and 20.4 and 22.2% in stover yield over no mulch. Application of 0.6 t lime/ha in furrow recorded the significantly higher yield attributes, grain yield (3.85 and 3.97 t/ha), stover yield (4.16 and 4.33 t/ha), gross return (41.87 and 43.25 $\times 10^3$/ha), net return (28.45 and 29.83 ×103/ha) and benefit: cost ratio (1.55 and 1.63) and quality attributes over rest of the levels, respectively. Application of farm yard manures @ 12 t/ha noted significantly higher yield attributes yield and quality attributes of maize over rest of the treatments. Similar effect of these treatments was observed on gross return of Rs. 40.75 and 41.78 $\times 10^3$/ ha, net return of Rs. 27.5 and Rs. 28.53 $\times 10^3$/ha and benefit : cost ratio of 1.52 and 1.57 in both the years, respectively.

Introduction

Maize (*Zea mays* L.) is the third most important cereal crop next to rice and wheat in India and an important cereal in the global agricultural economy. It is the most important cereal crop having wide distribution and varied uses as food, feed and fodder. In India, about 70% area and 75% production of maize is confined only in seven states *viz*. Andhra Pradesh, Karnataka, Rajasthan, Maharashtra, Bihar, Uttar Pradesh and Madhya Pradesh (Bhumla 2010). Due to low and erratic rainfall in dryland fringes, the major constraint for establishing crop is lack of adequate moisture in seed zone. Straw mulching is the most important practices that have been reported to reduce the soil erosion, increase *in situ* soil moisture conservation and improve the productivity of the crops (Bhatt *et al*. 2004). Despite beneficial effects of straw mulching, adoption of this practice is not common in tribal farmers of the North Eastern India including Nagaland also due to lack of utility and the awareness.

Soil acidity affect 50% of the world total potential cultivable land especially in humid region. In India, 1/3rd area of the total arable land is highly affected by the soil acidity and most of these soils are present in the North Eastern India. An estimate reveals that about 65% of total area falls under the extreme form of soil acidity in this region (Sharma and Singh 2002). In acid soil, potential productivity of crop is mainly affected by Al and Fe toxicity, P deficiency, low base

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saturation, impaired biological activity, acidity induced fertility and others nutritional problems (Kumar *et al.* 2012). Intensity of the acidity and its associated impact on fertility status of soil and crop productivity intensified in context of climate change (Kumar 2011). Hence, the reclamation of soil acidity through elimination of toxicity of Al and Mn and improving the productivity of crop on such soil is an important aspect for enhancing the food security. Nagaland is a potentially agricultural based economic state and having the acute problems of soil acidity coupled with high rainfall. Acidity induced soil fertility problems coupled with no use of inorganic fertilizers is responsible for low productivity of the crop in this region.

Liming along with FYM is recommended to increase phytoavailability of essential nutrient and ameliorate the acidity induced fertility problems on such soil (Kumar *et al.* 2012). Hence, a field experiment was conducted to assess the effect of mulching, liming and farm yard manure on productivity and profitability of maize in foot hill condition of Nagaland.

Materials and Methods

Field experiments were conducted at Agricultural Research Farm of ICAR Research Complex for North Eastern Hill Region, Jharnapani, Mezdiphema during two consecutive *rabi* season of 2010-2012 and located between 25.45^0 N latitude and 93.53^0 E longitudes with a mean altitude of 295 m above MSL. Soil was sandy loam in texture with acidic in nature (5.4), medium in organic carbon (0.71%) and available P (14.1 kg/ha) and low in mineralizable N (201.2 kg/ha) and available K (173.2 kg/ha). Experiment was laid out in split-split plot design and replicated thrice. Treatment comprised of two levels of mulch *viz*., without mulch (control) and straw mulch and mulch allocated to the main plot, four levels of liming *viz*., control, 0.2, 0.4 and 0.6 t/ha were allocated to the sub plot and four levels of farmyard manure (FYM) *viz*., 4, 8 and 12 t/ha allocated to sub-sub plot. Lime was applied to the field two weeks prior to the sowing of the crop. FYM were used in experiment as per treatments (0.5% N, 0.24% P and 0.55% K). The recommended doses of N, P and K were applied @ 80 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha, respectively through urea, di-ammonium phosphate and muriate of potash to the maize crop. The maize cv. Vijay composite was sown with the seed rate of 20 kg/ha on September 10 and September 14, respectively with the row spacing of 60 × 20 cm and harvested on January 04 and January 10 in 2011 and 2012, respectively. The total rainfall received in 2011 and 2012 was 250.5 mm and 327.9 mm, respectively. Five random plants were sampled from each plot for recording data on yield attributes at harvest. The length of each five randomly selected cobs from each plot was measured. No. of row/cob, no. of grain/row, no. of grain/cob was also counted. The 1000-grain weight from representative samples taken from the produce. The maize cobs were stripped off their husk and air dried and shelled separately. The dry shelled grains yield and store yield were recorded computed into t/ha. Harvest index (HI) was calculated by dividing the economic yield with the biomass yield and expressed in percentage.

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield}}{\text{Biomass yield}} \times 100$$

The cost of cultivation, gross return, net returns and benefit cost ratio of different treatment were worked out on the basis of prevailing market prices. Net return (Rs./ha) was calculated by deducting the cost of cultivation (Rs./ha) from gross returns while benefit: cost ratio were worked out as ratio of gross return (Rs./ha) to cost of cultivation (per ha) as follows:

Net return (per ha) = Gross return (Rs./ha) - cost of cultivation (Rs./ha)

Benefit: cost ratio = Gross return (Rs./ha)/total cost of cultivation (Rs./ha)

Data collected on maize were statistically analyzed and compared at p = 0.05 level of significance (Cochran and Cox 1992).

Results and Discussion

Mulching had significant influences on the yield attributes during both the years of study (Table 1). Significantly higher cob length, number of row/cob, number of grain/row, number of grain/cob and 1000-grain weight were recorded in straw mulching which was 10.2, 6.67, 8.66, 10.56, 13.6% and 10.54, 6.28, 8.61, 10.47, 14.2% higher over no mulch in 2010-11 and 2011-12, respectively. Significant difference was also observed in grain, stover and biological yield due to straw mulching (Table 1). The per cent increase in grain yield was 15.9 and 16.5, stover yield of 20.3 and 22.2 and biological yield 18.5 and 19.6 over no mulch in both years, respectively. This was due to decrease in evaporation and availability of adequate soil moisture for longer period. Application of surface mulch restricted upward flux of water and maintained optimum soil moisture condition (Gupta and Acharya 2002). In limited water supply, through conservation of moisture and regulation of soil temperature, hence maize yield was increased (Ondal *et al.* 2008). Inadequate moisture supply under no mulching resulted in low grain yield due to deleterious effect on most of the physiological process of the crop (Sharma *et al.* 2009). The present findings are also in agreement with those of Sidhu *et al.* (2007) who concluded crop residue on soil increased soil temperature and soil water contents, improved ecological environment of field and increased maize yield.

The results further revealed that gross, net return and B : C ratio of maize increased significantly due to straw mulching in both the years (Table 2). The maximum gross return (Rs. 37.68 and 38.96 $\times 10^3$/ha), net return (Rs. 25.51 and 37.68 $\times 10^3$/ha) and B: C ratio (1.56 and 1.64) was observed with straw mulching in 2011 and 2012, respectively. Increase in yield of maize resulted in increase of these economic parameters (Sharma *et al.* 2011). Similarly, straw mulch also gave the significantly higher production efficiency (29.3 and 29.7 kg ha/day) and economic efficiency (Rs. 218.1 and 225.2 ha/day) of the maize in both the year, respectively (Table 3).

A significant improvement in quality parameters of maize *viz*., carbohydrate, starch and sugar was noted with the application straw of mulch in both the years (Table 3). Higher values of carbohydrate (69.2 and 69.5%), starch (64.1and 64.6%) and sugar (1.46 and 1.49%) were recorded with straw mulch in both the years, respectively, whereas, the lowest was recorded under no mulch. Straw mulching conserved moistures and make favourable environment in rhizosphere, which provided nutrients in the soil. Zamir *et al.* (2013) reported that wheat straw as mulch significantly increased quality i.e. protein and oil content in maize.

Increasing levels of liming significantly increased cob length, number of row/cob, number of grain/row, number of grain/cob and 1000-grain weight than lower doses of lime in both the years (Table 1). Among the levels of liming, lime applied @ 0.6 t/ha recorded an increase of 17.6, 11.7, 13.6, 18.8, 13.6 and 17.9% in 2010-11 and 16.7, 20.2, 14.8 and 18.9% in 2011-12 over control, respectively. The grain, stover and biological yield of maize significantly increase with increasing levels of liming up to 0.6 t/ha (Table 2). The increase in grain, stover and biological yield were 49.8, 23.4 and 34.9% in the year 2010-11 and 50.4, 25.9 and 36.4% in 2011-12 over control, respectively under the treatment of liming @ 0.6 t/ha. Harvest index also influenced markedly by different levels of liming and recorded the maximum with the application of lime @ 0.6 t/ha in both the year. This is might be due to effect of liming in the lowering of exchangeable Al^{3+} and H^+ and to an increase in Ca, Mg, CEC and pH. Chatterjee *et al.* (2005) reported that incorporation of lime @ 10, 50 and 100% lime requirement (LR) of soil in furrows increased dry pod and haulm yield over treatment receiving recommended dose of NPK (25 : 50 : 50) alone, thereby signifying graded response to liming. Similar lines of finding were also noted in maize by Mafouasson *et al.* (2006). Application of lime @ 6 q/ha recorded the maximum gross return (Rs. 41.87 and 43.25 $\times 10^3$/ha), net return (Rs. 28.45 and 29.83 $\times 10^3$/ha) and B: C ratio (1.55 and 1.63), which was 46.6,

Table 1. Effect of mulching, liming and farm yard manures on yield attributes of maize at harvest.

Treatment	Cob length (cm)		No. of rows/cob		No. of grains/row		No. of grains/cob		1000-grain weight (g)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Mulching										
Control	14.01	14.32	12.43	12.57	26.90	27.74	248.60	251.80	198.60	199.82
Straw mulching	15.44	15.83	13.26	13.36	29.23	30.13	274.86	278.17	225.60	228.19
SE	0.15	0.20	0.13	0.14	0.33	0.34	2.92	3.31	3.23	3.29
CD (p = 0.05)	0.94	1.24	0.80	0.88	2.03	2.07	17.78	20.12	19.68	20.04
Lime (t/ha)										
Control	13.59	13.92	12.14	12.17	25.54	26.14	244.77	246.74	194.77	195.16
0.2	14.23	14.57	12.58	12.65	27.26	28.04	255.89	259.28	205.89	208.77
0.4	15.10	15.56	13.11	13.22	29.13	30.17	268.16	270.59	218.16	219.95
0.6	15.98	16.25	13.56	13.83	30.34	31.41	278.09	283.34	229.56	232.14
SE	0.16	0.17	0.12	0.13	0.31	0.33	2.90	3.19	3.02	3.52
CD (p = 0.05)	0.50	0.51	0.37	0.40	0.96	1.00	8.94	9.83	9.32	10.83
FYM (t/ha)										
4	13.71	14.22	12.18	12.29	26.83	27.64	251.05	252.94	201.05	202.77
8	14.87	15.14	12.83	13.01	28.13	29.06	259.94	264.24	211.05	212.92
12	15.60	15.87	13.54	13.61	29.24	30.11	274.20	277.79	224.20	226.33
SE	0.13	0.15	0.09	0.10	0.24	0.27	2.45	2.48	2.20	2.39
CD (p = 0.05)	0.38	0.42	0.27	0.28	0.69	0.78	7.05	7.10	6.35	6.88

Table 2. Effect of mulching, liming and farm yard manures on yield and economics of maize.

Treatment	Grain yield (t/ha)		Stover yield (t/ha)		Biological yield (t/ha)		Harvest index (%)		Gross return (× 10^3 Rs./ha)		Net return (×10^3 Rs./ha)		B:C ratio	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Mulching														
Control	2.95	3.04	3.44	3.51	6.38	6.55	45.77	46.00	32.32	33.27	20.65	21.60	1.32	1.38
Straw mulching	3.42	3.54	4.14	4.29	7.57	7.83	44.83	44.81	37.68	38.96	25.51	26.80	1.56	1.64
SE	0.04	0.05	0.04	0.04	0.06	0.06	0.36	0.46	0.39	0.48	0.34	0.39	0.02	0.02
CD (p = 0.05)	0.24	0.30	0.22	0.24	0.35	0.36	NS	NS	2.35	2.91	2.31	2.35	0.14	0.15
Lime (t/ha)														
Control	2.57	2.64	3.37	3.44	5.94	6.09	43.28	43.40	28.56	29.33	18.15	18.91	1.32	1.38
0.2	2.95	3.03	3.69	3.79	6.64	6.82	44.36	44.41	32.58	33.48	21.16	22.06	1.41	1.47
0.4	3.37	3.51	3.94	4.05	7.31	7.55	46.11	46.42	36.99	38.40	24.57	25.98	1.47	1.56
0.6	3.85	3.97	4.16	4.33	8.01	8.30	47.45	47.39	41.87	43.25	28.45	29.83	1.55	1.63
SE	0.03	0.04	0.04	0.05	0.06	0.07	0.23	0.34	0.35	0.37	0.32	0.35	0.02	0.02
CD (p = 0.05)	0.10	0.11	0.13	0.15	0.18	0.22	0.72	1.03	1.06	1.14	1.04	1.08	0.05	0.06
FYM (t/ha)														
4	2.66	2.74	3.40	3.51	6.06	6.25	43.74	43.69	29.42	30.37	18.84	19.79	1.36	1.43
8	3.16	3.29	3.84	3.97	7.00	7.26	45.14	45.01	34.83	36.19	22.91	24.28	1.44	1.52
12	3.74	3.83	4.12	4.22	7.86	8.05	47.33	47.19	40.75	41.78	27.50	28.53	1.52	1.57
SE	0.04	0.05	0.04	0.04	0.05	0.06	0.34	0.39	0.38	0.45	0.38	0.39	0.01	0.02
CD (p = 0.05)	0.11	0.13	0.10	0.11	0.16	0.17	0.98	1.12	1.10	1.29	1.10	1.12	0.04	0.06

Table 3. Effect of liming and farm yard manures on quality parameters of maize.

Treatment	Carbohydrate (%)		Starch (%)		Sugar (%)		Production efficiency (kg ha/day)		Economic efficiency (Rs. ha/day)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Mulching										
Control	67.38	67.53	57.70	57.97	1.28	1.30	25.19	25.52	176.52	181.50
Straw mulching	69.19	69.52	64.08	64.57	1.46	1.49	29.25	29.73	218.06	225.18
SE	1.13	1.17	0.94	1.10	0.02	0.02	0.42	0.33	3.24	4.09
CD (p = 0.05)	6.91	7.09	5.74	6.68	0.11	0.15	2.54	1.98	19.74	24.91
Lime (t/ha)										
Control	65.11	65.15	57.04	57.17	1.18	1.19	21.98	22.19	155.10	158.91
0.2	68.27	68.34	59.77	60.31	1.36	1.38	25.19	25.46	180.86	185.42
0.4	68.86	69.36	62.14	62.64	1.42	1.45	28.82	29.46	210.02	218.35
0.6	70.90	71.25	64.60	64.96	1.52	1.55	32.88	33.38	243.18	250.69
SE	0.57	0.58	0.69	0.71	0.02	0.02	0.32	0.27	2.90	3.15
CD (p = 0.05)	1.75	1.79	2.10	2.22	0.05	0.06	0.97	0.82	8.93	9.72
FYM (t/ha)										
4	66.33	66.52	58.16	58.62	1.28	1.30	22.69	23.03	161.01	166.26
8	68.41	68.58	60.68	61.13	1.38	1.41	27.03	27.63	195.83	204.01
12	70.11	70.48	63.84	64.06	1.45	1.47	31.94	32.21	235.04	239.76
SE	0.58	0.59	0.52	0.55	0.01	0.02	0.39	0.32	3.26	3.86
CD (p = 0.05)	1.67	1.69	1.50	1.57	0.04	0.05	1.12	0.93	9.39	11.11

56.7 and 17.4% and 47.5, 57.7, 18.1% higher than no liming in 2010-11 and 2011-12, respectively (Table 2). Similar effect of these treatments were recorded on production efficiency (32.9 and 33.4 kg/ha/day) and economic efficiency (Rs.243.2 and 250.7 ha/day) in respective years of study (Table 3).

The increase in carbohydrate, starch and sugar under lime applied @ 0.6 t/ha was 20.2, 12.7, 8.9, 17.9, 28.8, 13.3, 28.8% and 23.5, 21.6, 9.4, 17.9, 31.3, 13.6, 30.3% in the year 2010-11and 2011-12, respectively. Experimental results showed that treatment receiving lime @ 100% LR increased the uptake of N and P by 82 and 69%, respectively over the treatment receiving recommended dose of NPK fertilizers alone (Chatterjee *et al.* 2005).

The maximum cob length (15.6 and 15.9 cm), number of rows/cob (13.5 and 13.6), no. of grains/row (29.2 and 30.1), no. of grain/cob (274.2 and 277.8) and 1000-grain weight (224.2 and 226.3 g) were recorded with application of FYM @ 12 t/ha in both the years, respectively (Table 1). This may be attributed primarily to the beneficial role of FYM in improving the physical properties of soil due to the formation of acids during decomposition of organic matter and increased available nutrient for plant growth and development. Similar results were reported in pearlmillet by Jakhar *et al.* (2006).

Different levels of FYM significantly influenced the grain, stover and biological yield of in both the years. The magnitude of increase in grain, stover and biological yield was 40.6, 21.2, 29.8% and 39.8, 20.2, 28.7% due to FYM 12 t/ha over 4 t FYM/ha in both the respective years. Higher harvest index was also recorded with the application of FYM @ 12 t/ha which was 8.2 and 8% higher over 4 t FYM/ha in 2010-11 and 2011-12, respectively. Improvement in yield attributes and yield of the crop may be attributed to better nutrient availability and favourable effect on soil physical and biological properties resulting in increased growth and yield attributes and finally higher yield. Increase in grain and stover yield of pearl millet due to application of FYM has been reported by Jakhar *et al.* (2006). Similarly, application of FYM @ 10 t/ha had significant improvement in green fodder and dry fodder yield of sorghum in comparison to without FYM (Meena and Meena 2012).

Application of FYM @ 12 t/ha brought substantial improvement in gross, net return and B: C ratio (Table 2). Application of FYM @ 12 t/ha gave significantly higher gross return of Rs. 40.75 and 41.78 ×103/ha, net return of Rs. 27.50 and 28.53 ×103/ha and B:C ratio of 1.52 and 1.57 of than 4 t/ha of FYM in 2010-11 and 2011-12, respectively. On the contrary, the lowest gross return (Rs. 29.42 and 30.37×103/ha), net return (Rs.18.84 and 19.79 ×103/ha) and B: C (1.36 and 1.43) was observed with 4 t FYM/ha during the respective year. Higher production efficiency (31.94 and 32.21 kg/ha/day) and economic efficiency (Rs. 235.04 and 239.76 Rs/ha/day) were recorded under FYM @ 12 t/ha (Table 3).

Among FYM levels, application of 12 t FYM/ha improves carbohydrate by 5.7, 5.95%, starch 9.67, 9.28% and sugar 13.28, 13.07% over 4 t FYM/ha in 2010-11 and 2011-12, respectively (Table 3). It was obvious because of favourable influence of FYM on availability and uptake of N, P and K which increased substantially and since protein content being function of N concentration of plant also increased markedly under influence of FYM.

From the two years study, it is concluded that straw mulching and application of lime 0.6 t/ha along with FYM 12 t/ha proved the best management practice to achieve the sustainable production of maize under foot hill condition of Nagaland in rainfed condition.

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References

Bhatt R, Khera KL and Arora S 2004. Effect of tillage and mulching on yield of corn in the sub-montaneous rainfed region of Punjab. India Internat. J. Agricul. Biol. **6**: 26-28.

Bhumla DR 2010. Role of fertilizers in food grain production. J. Indian Soc. Soil Sci. **58**(S): 589-597.

Chatterjee A, Doshni AAK, Talashikar SC and Mehta VB 2005. Effect of lime on yield, quality and nutrient uptake by six groundnut varieties and properties of an Alfisol. J. Indian Soc. Soil Sci. **53**(3): 128-132.

Cochran WG and Cox GM.1992. *Experimental Design.* Asia Publishing House, New Delhi.

Gupta RK and Acharya CL 2002. Water management in rainfed soil. *In:* Fundamentals of Soil Science, Indian Society of Soil Science, New Delhi. pp. 133-144.

Jakhar SR, Singh M and Balai CM 2006. Effect of farmyard manure, phosphorus zinc levels on growth, yield, quality and economics of pearlmillet (*Pennisetum glaucum*). Indian J. Agril. Sci. **76**(1): 58-61.

Kumar M, Khan MH, Singh P, Ngachan SV, Rajkhowa DJ, Kumar A, Devi MH 2012. Variable lime requirement based on differences in organic matter content of iso-acidic soils. Indian J. Hill Farming **25** (1):26-30.

Kumar M 2011. North East India: Soil and water management imperatives for food security in a changing climate. Curr. Sci. **101**: 1119.

Mafouasson HA, Meka SS and Horst WJ 2006. Responses of maize grain yield to changes in acid soil characteristics after soil amendments. Plant and Soil **284**: 45-57.

Meena LR and Meena SL 2012. Production potential, nutrient uptake, economics and soil properties as influenced by fodder sorghum (*Sorghum bicolor*) cultivars, nitrogen levels and FYM under semiarid condition of Rajasthan. Range Management & Agroforestry **33**(2): 171-176.

Ondal NAM, Ossain SMAH, Huiya SUB and Ahiruddin MJ. 2008. Productivity of rainfed mustard in relation to tillage and mulching. Bangladesh J. Agril. Res. **33**: 597-606.

Sharma AR, Singh R, Dhyani SK and Dube RK. 2009. Moisture conservation and nitrogen recycling through legume mulching in rainfed maize (*Zea mays*) - wheat (*Triticum aestivum*) cropping system. Nutrient Cycling in Agroecosystems **87**(2): 187-197.

Sharma P, Abrol V and Sharma RK. 2011. Impact of tillage and mulch management on economics, energy requirement and crop performance in maize-wheat rotation in rainfed sub humid Inceptisols, India. European J. Agron. **34**: 46-51.

Sharma UC and Singh RP 2002. Acid soils of India: their distribution, management and future strategies for higher productivity. Fertilizer News **47**: 45-52.

Sidhu AS, Sekhon NK, Singh S, Thind SS and Hira GS 2007. Soil temperature, growth and yield of maize (*Zea mays* L.) as affected by wheat straw mulch. Archives Agron. Soil Sci. **53**: 95-102.

Zamir MSI, Javeed HMR, Ahmed W, Ahmed AUH, Sarwar N, Shehzad M, Sarwar MA and Iqbal S 2013. Effect of tillage and organic mulches on growth, yield and quality of autumn planted maize (*Zea mays* L.) and soil physical properties. Cercetări Agronomice in Moldova XLVI **2**(154): 17-26.

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