Evaluation of Fertilizer Management on Different Maize Varieties in Southern Shan State

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Abstract

The study was carried out with two objectives (1) to observe the highest fertilizer response on growth performance of grain maize varieties and (2) to determine the effect of fertilizer management practices in response on yield and yield components. The field experiment was conducted at Aung Ban Research Station under Department of Agricultural Research by using split plots design with three replications. Five maize varieties were used as tested varieties under four levels of fertilizer management practices. Sustainable and Affortable Poultary for All (SAPA) fertilizer application practice gave the highest grain yields, yield components and agronomic parameters than the others. It may be probably due to higher fertilizer application rate together with micronutrients especially more potassium application with S, Ca and Mg than other practices. Among the varieties, NK 621 variety gave the maximum yield, yield components such as number of kernels per row, thousand seeds weight and agronomic characters such as SPAD value, ear weight and ear diameters. "In combination effect of SAPA fertilizer and SA 282 variety gave the maximum yield but the yield of SA 282 was not significantly different with NK 621. Therefore, these two varieties were found as the best performing in grain yield and good potential for the future in Southern Shan State.

Key words: Maize Varieties, Fertilizer Management, SAPA, GAP, Southern Shan State

Introduction

Poor management of fertilizer has major key role to play in obtaining low yield productivity, so in order to achieve optimum crop productivity management of nutrients through careful application of organic sources, bio-fertilizers and micro-nutrients are required (Ghaffari et al. 2011). In addition, the fertilizer management is one of the most important factors that influence the growth and yield of maize crop. Maize is considered as most exhaustive crop after sugar cane and requires both micro and macro nutrients to obtain high growth and yield potentials. In fact, organic nutrients not only provide plant with nutrients but also improve and or sustain the soil health. The micronutrients content in organic manure may be sufficient enough to meet the crop production requirement but problem of low soil fertility is one of the obstacles to maintain and sustain agricultural production and productivity (Kumar, 2011).

Good Agriculture Practices (GAP) have encouraged to farmer that address environmental, economic and social sustainability for on-farm processes and to be better results in safe and quality food and non-food agriculture products. The GAP package consisted with land preparation, plant density with number of seeds per hole, time and frequency of weeding and pest and diseases control. Adoption of GAP creates the chances for farmers to have higher profits in grain yield and food safety. Increase in productivity can be achieved by better agronomic management such as proper planting and weeding which increase the efficiency of available nutrients, water and labor.

Fertilizer application and management play an important role in increasing the maize yield and their contribution is 40-45 percent. . In spite of the increase in land areas under maize production yield is still low. Some of the major causes of low maize yield are declining soil fertility and insufficient use of fertilizers resulting in severe nutrient depletion of soils (Bruesh et al. 1997).

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Nitrogen (N) is important nutrient to maximize crop growth, thus it is often applied to agricultural crops if available (Tilman et al. 2011). Although N fertilizer application can improve maize yields, if overused, it can also have negative environmental impacts such as groundwater pollution through nitrate leaching or increased global warming resulted to N_2O emissions (Burney et al. 2010).Potassium (K), one of these 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 (Bukhsh 2010). Maize takes up potassium (K) in a relatively large amount. About 86% of K taken up has accumulated by silking and only 19% of this K is contained in the ear and shank portion. Maize takes up to 38% of the total K for the whole growing season, during 38 to 52 days after sowing (Rehman et al. 2008).Therefore, the present study was undertaken with the following objectives;

- to observe the highest fertilizer response on growth performance of grain maize varieties,
- to determine the effect of fertilizer management practices in response on yield and yield components

Materials and Methods

The experiments were conducted at Aung Ban Research Station during wet season from April to September of 2017 by using split plots design with three replications. Five maize varieties were used as tested varieties under four levels of fertilizer management practices. Method of fertilizer application was assigned as "main plots" and maize verity was assigned as "sub plot". Firstly, land was prepared by two times of ploughing and two times of harrowing. In this experiment, all treatments were applied with cow dung manure (2178.52 kg/ha) at basal fertilizer application in table 1.

Main plot factor (Different fertilizer management practices)

F_1 – Control

F_2 - Farmers' practice of fertilizer management practice

F_3 - GAP fertilizer management practice

F_4 - SAPA guideline fertilizer management practice

Where,

F1 = Cow dung manure without inorganic fertilizer

F2 = Urea (123.5 kg/ha) + Compound fertilizer (123.5 kg/ha)

F3 = Urea (185.3 kg/ha) + P_2O_5 (123.5 kg/ha) + MOP (123.5 kg/ha)

F4 = Urea (290 kg/ha) + P_2O_5 (123.5 kg/ha) + MOP (123.5 kg/ha) + micronutrient (313.61 kg/ha)

Sub plot factor (Different varieties)

V1 - Yezin 11 (Released from DAR)

V2 - NK 625 (Released from Awba Co.)

V3 - CP 888 (Released from CP Co.)

V4 - SA 282 (Released from Seed Asia Co.)

V5- NK 621 (Introduced from Awba Co.)

During the experimental period, plant height and chlorophyll content (SPAD value) were collected by two weeks intervals starting from 14 DAS to 56 DAS (Days after sowing). Plant characters such as days to 50% tasseling, days to 50% silking, ear diametr (cm), ear length (cm), ear weight (g) and seed weight ear $^{-1}$ were measured from randomly selected ten ears and the average values were recorded at harvest. Five plants were randomly selected from each plot and plant height was measured at two weeks interval. Plant height was measured from the ground level to the uppermost fully expended leaf before tasseling. For SPAD value, non-destructively with the portable SPAD meter (M -502) or chlorophyll meter was used. It measured the youngest fully expanded leaf before silking.

The number of rows ear^{-1}, number of seeds row^{-1}, number of ears plant-^{1,} thousand seeds weight and yield components were recorded from randomly selected 5 sample plants of each plot at harvesting. Plants from m^2 of each plot were used as harvest area yield and converted to ton ha^{-1}.

$$\text{Yield} = \frac{(100\text{-Moisture\%}) \times \text{Field weigh (kg)} \times \text{Shelling \%} \times 10000}{85 \times \text{Harvested area (m}^2) \times 1000}$$

(CIMMYT 1985)

Where,

Ton ha^{-1}=seed yield converted into tons per hectare

85=adjusted factor of seed moisture to 15 %

10,000 sq meter =conversion factor to an area of one hectare of a plot

1000=kg per ton

Shelling %

$$\text{shelling (\%)} = \frac{\text{Seed dry weight}}{\text{Ear dry weight}} \times 100$$

Harvest Index (HI)

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

Results and Discussion

Yield and Yield components

In different fertilizer management practices, SAPA fertilizer management practice gave the maximum grain yield, number of row per ear, number of kernels per row, thousand seed weight and harvest index (Table 2). In grain yields, the highest grain yield produced by SAPA fertilizer management practices may due to the production of higher grain yields with respective level of NPK plus micronutrient management practices. Adequate supply of nitrogen and micronutrients in maize can increase the crop growth, photosynthesis process, respiration and other biochemical and physiological activities which help in increasing yield attributes (Zeidan et al. 2010). It was observed that grain yields of SA 282, NK 621, CP 888 and NK 625 varieties were higher than Yezin 11 variety (Table 2). The maximum grain yield were obtained from NK 621 and SA 282 The minimum yield was obtained from Yezin 11 .The highest amount of fertilizer in SAPA gave the highest number of rows per ear. Moraditochaee et al. (2012) also observed that the management practices of N fertilizer was not significant different on number of row per ear.

In comparison between the varieties, the maximum number of row per ear was found in NK 625 and NK 621 whereas the minimum number of row per ear was found in CP 888. The maximum number of kernels row^{-1} was obtained from SAPA management practices in table 2. Wadile et al. (2016) stated that the source - sink relationship and the rate at which translocation takes place from source during the reproduction stage largely determine grain yield. Maize yield is a function of different yield components such as the number of cobs ha^{-1}, length and girth of cob, number of kernels per row of cob, 1000 grain weight and shelling percentage. The two tested varieties NK 625 and NK 621 gave the larger number of kernels per row as compare to others. The smallest number of kernels per row was obtained from CP 888. Among the fertilizer levels, the highest thousand seeds weight was obtained from SAPA fertilizer management practice. Amoruwa et al. 1987 observed that thousand grains weight increased with increasing nitrogen rate. The maximum thousand seeds weight was obtained from NK 621 and NK 625 respectively .The minimum thousand seeds weight was observed SA 282.

The highest harvest index was obtained by SAPA fertilizer management practice followed by

Table 1. Different four treatments of fertilizer management practices on maize

Fertilizer Management Practices	Time and rate of fertilizer application (kg/ha)				Total
	Basal	20-23 DAS	40 DAS	60 DAS	
Control					
Cow dung manure	519.63				519.63
Farmer					
Cow dung manure	519.63				519.63
Urea		61.75	61.75		123.5
Compound	123.5				123.5
GAP					
Cow dung manure	519.63				519.63
Urea	123.5	61.75	61.75		185.3
P_2O_5	123.5				123.5
MOP	123.5				123.5
SAPA					
Cow dung manure	519.63				519.63
Urea	124	49.4	42	24.7	290
P_2O_5	123.5				123.5
MOP	123.5				123.5
$CaNO_3$		148.2			148.2
$MgSO_4$		98.8			98.8
Korn-Karli B			24.7	41.99	66.61

the GAP fertilizer management practices practice in table 2. The lowest harvest index was obtained from control. The increased in harvest index in SAPA might be due to the increased thousand seed weight. Lawrence (2008), reported that harvest indies in corn increases when nitrogen rates increases. The harvest index (HI) of tested varieties were highly significant different and the HI of SA 282, NK 621, CP 888, NK 625 and Yezin 11 were 0.41, 0.35, 0.37, 0.38 and 0.34 respectively.

Agronomic Characters of Maize

Though not significantly different in plant height under different fertilizer levels the maximum plant height was observed from SAPA fertilizer management practices followed by GAP fertilizer management practice in table 3. The minimum plant height was observed from control treatment. It might be due to increased root growth, which strengthened the stem against lodging during prolong vegetative growth. Increasing of plant height with increasing nitrogen levels was stated by Hokmalipour et al. (2010). Significant different in plant height was found in among the tested varieties. The maximum plant height was observed from CP 888 and NK 621 respectively while the lowest plant height was obtained from SA 282 among other varieties. According to the result, the maximum SPAD meter was observed from SAPA fertilizer management practice and followed by farmer practice at 42 days after sowing in table 2. Varvel et al. (1997) observed N fertilizer significantly increased both maize seed yield and SPAD readings. The maximum SPAD value was observed from NK 621 and NK 625 respectively while the minimum number of SPAD value was obtained from Yezin 11 among other varieties.

The comparison of means observed that the greater number of days to 50% tasseling was obtained by GAP and SAPA fertilizer management practices (Table 3). The smallest number of days to 50% tasseling was obtained from control. This might be due to the higher level of NPK prolonged the vegetative growth stage of the plant rather longer period of time resulting in more days taken to tasselling. Namvar and Seyed Sharifi (2011) suggested that phonological events were significantly delayed by the increasing rate of mineral N than by other sources. The maximum days to 50% tasseling was detected from NK 625 followed by NK 621. The minimum days to 50% tasseling was obtained from SA 282. Different fertilizer management practices showed no significant variation but different varieties were highly significant in days to 50% silking in table 3. The comparison of means observed that the greater number of days to 50% siliking was obtained by F3 and F4 treatment. The smaller number of days to 50% siliking was obtained from F1 of control. The greater number of days taken to silking may be due to the more succulent vegetative growth of the plant. This might be due to the adequate nitrogen in combination with P and K which greatly influenced vegetative growth of plant. The varieties, however, did not affect the number of days taken to silking. Low nitrogen level could have adverse effect on the production of reproductive cells. The shortest period to silking under 200 kg N ha^{-1} and the longest period to silking under 0 kg N ha-1 were obtained (Shrestha 2013). The maximum days to 50% silking was detected from NK 625 and Yezin 11 respectively.

According to the result, the greater number of days to maturity was obtained by F3 and F4 treatments in table 3. The smaller numbers of days to maturity was obtained from farmer fertilizer management practice and control. Namvar and Seyed Shatifi (2011) observed the duration of vegetative and reproductive period to see what is a proof of lengthening of the time to maturity. In this study, the greater days to maturity was detected from NK 625 and CP 888 respectively. The smaller days to maturity was obtained from SA 282. The mean value of ear weight was significant different at 5% level among fertilizer management practices, however, there was highly significantly different at 1% level among different varieties in table 2. According to the result, the maximum ear weight was observed from SAPA fertilizer management practice followed by GAP fertilizer management practice. The smallest ear weight was observed from control treatment. Blumenthal et al. (2003) mentioned that increasing nitrogen is significantly increased grain weight in maize. Increasing nitrogen fertilization rates led to a significant increase in ear length, number of seed row^{-1}, ear weight and seed yield. The maximum ear weight was detected from NK 621 followed by NK 625 whereas the minimum ear weight was obtained from the variety of SA 282. The mean value of ear length showed no significant different fertilizer management practices in table 2. The result from the study observed that the maximum ear length

Table 2. Yield and yield components as affected by fertilizer management practices and five varieties

Treatments	Grain Yield (kg)	No.of ear per plant	No.of row per ear	No.of kernels per row	Thousand seed weight (g)	Shelling %	Harvest Index
Fertilizer (A)							
Control	5063 c	1.2 a	12.90 b	33.94 a	301.50 b	80.48 a	0.34 a
Farmer	6545 b	1.29 a	13.06 ab	35.89 a	313.77 b	80.64 a	0.37 a
GAP	6758 b	1.27 a	13.41 ab	37.10 a	326.14 b	83.03 a	0.39 a
SAPA	8279 a	1.29 a	13.57 a	37.22 a	351.66 a	82.48 a	0.39 a
LSD $_{0.05}$	572.5	0.25	0.60	3.33	25.31	6.43	0.85
Varieties (B)							
Yezin 11	5607 c	1.19 bc	12.64 b	36.2 ab	325.68 abc	80.34 ab	0.34 b
NK 625	6743 ab	1.17 bc	14.20 a	37.92 a	327.76 ab	81.38 ab	0.38 ab
CP 888	6521 ab	1.56 a	11.41 c	34.13 b	312.81 bc	82.38 ab	0.37 ab
SA 282	7090 a	1.33 b	13.92 a	35.19 ab	299.92 c	83.43 a	0.41 a
NK 621	7346 a	1.05 c	14.01 a	36.59 ab	350.17 a	77.97 b	0.35 b
LSD $_{0.05}$	689.9	0.20	0.57	2.96	26.94	4.49	0.49
Pr>F							
F	**	ns	*	ns	ns	ns	ns
V	**	**	**	ns	**	ns	**
F*V	ns	ns	ns	ns	*	ns	ns
CV % (a)	23.54	14.1	3.08	11.14	7.63	4.53	25.61
CV% (b)	25.74	14.76	5.36	9.72	9.89	4.09	15.94

* significant at 5% level, ** highly significant different at 1% level, ns = non significant
Means followed by same letter were not significantly different.

Table 3. Agronomic characters of the varieties as affected by fertilizer management practices

Treatment	Days to 50% tasseling	Days to 50% silking	Days to maturity	Ear weight (g)	Ear Length (cm)	Ear diameter (cm)
Fertilizer (A)						
Control	69.06 a	70.60 a	126.93 a	210.51 b	17.05 a	4.44 c
Farmer	69.07 a	70.87 a	126.80a	237.23 a	17.45 a	4.58 b
GAP	69.13 a	72.13 a	127.00 a	252.12 a	17.81 a	4.72 a
SAPA	69.33 a	71.33 a	127.27 a	259.23 a	19.99 a	4.74 a
LSD $_{0.05}$	0.6	1.64	1.82	23.63	1.03	0.12
Varieties (B)						
Yezin -11	69.08 b	71.58 a	127.58 a	239.27 b	19.93 a	4.41 bc
NK-625	70.25 a	71.83 a	128.08 a	269.64 a	17.03 b	4.49 a
CP- 888	69.17 b	71.00 a	127.58 a	189.60 c	16.64 b	4.33 c
SA-282	68.75 b	69.33 b	124.50 b	207.67 c	16.33 b	4.53 b
NK-621	69.17 b	71.17 a	127.25 a	292.69 a	18.47 a	4.58 a
LSD $_{0.05}$	0.69	1.2	1.22	28.13	1.11	0.15
Pr>F						
F	ns	ns	ns	*	ns	*
V	**	**	**	**	**	**
F*V	ns	ns	ns	ns	ns	ns
CV% (a)	0.98	2.58	2.58	11.03	7.71	2.85
CV% (b)	1.2	2.04	3.58	14.11	5.79	3.85

*significant at 5% level, ** highly significant different at 1% level, ns = non significant
Means followed by same letter were not significantly different.

was obtained from SAPA fertilizer management practice. The second maximum ear length was obtained from SAPA fertilizer management practice. The minimum ear length was observed in control. This could be due to better nutrient uptake and efficient assimilation of applied nutrients resulted in cob length, cob diameter and number of grains cob^{-1} and thus lead to more grain yield. Numerically, the maximum ear length was observed from Yezin 11 and NK 621. The minimum ear length was obtained from SA 282 among other varieties.

The mean value of ear diameter was significantly different at 5% level among fertilizer management practices, however, there was highly significantly different 1%level among different varieties in table 2. The result indicated that the largest ear diameter was observed from SAPA fertilizer management practices followed by GAP fertilizer management practices (F3) in table 2. The smallest ear diameter was observed from control treatment. Gul et al. (2015) informed that stover yield could be due to better nutrient uptake and efficient assimilation of applied nutrients resulted in more leaf, cob diameter and number of grains ear^{-1}. This might be due to the production of ear diameter with respective levels of NPK and micronutrients applications. The largest ear diameter was observed from NK 621 and SA 282 respectively. The smallest number of ear diameter was obtained from CP 888 among other varieties.

Conclusion

The SAPA fertilizer management practice contributed the highest yield of maize in the value, highest ear length, row length, ear diameter, rows ear^{-1}, 1000 grain weight and SPAD value. SAPA fertilizer management practices produced more yield than other practices. It may probably due to higher fertilization management practices with minor nutrients, especially in more potassium management practices with S, Ca and Mg than other practices..

GAP fertilizer management practices produce second higher yield in this experiment. It also applied higher fertilizer management practices than farmer practices. GAP fertilizer management practices produced more yield than farmer practices but it is necessary to put more K and micro nutrients to get maximum return. Farmer fertilizer management practices mostly used compound fertilizer and urea. It is necessary to educate farmer to use more balance fertilizer management practices to get maximum yield.

In varietal experiment, NK 621 variety produced the highest yield than other varieties. And it also accompanied with the highest values in ear weight (g), ear diameter (cm), kernels row^{-1}, SPAD

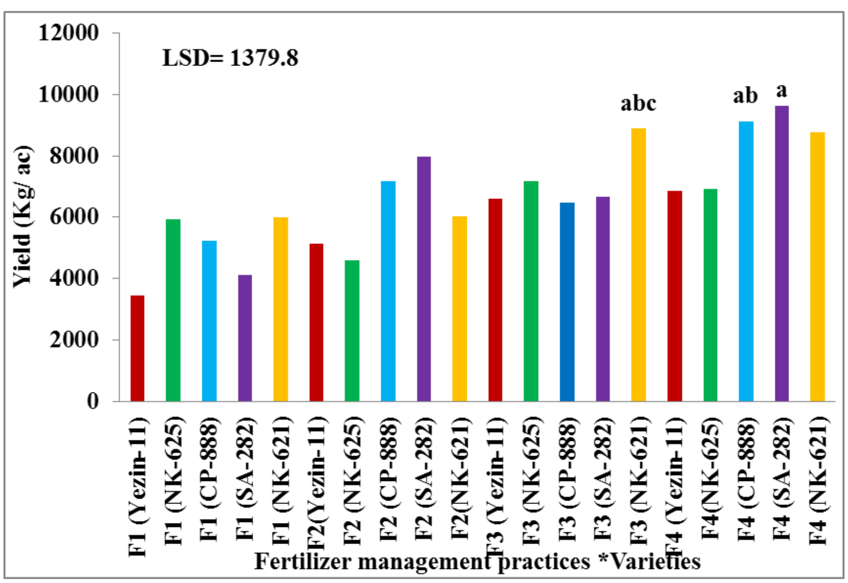

Figure 1. Combination effect of different fertilizer management practices and different varieties on grain yield of maize, 2017

value and 1000 seeds weight. It was found that among the different varieties NK 621 produced more yield, followed by NK 625 and SA 282, but they were not significantly different each other. Therefore, these three varieties were suited for high fertilize management practices. The interaction effect showed that the highest grain yield was obtained with SAPA fertilizer management practice of NK 621, followed by CP 888, but they were not significantly different. Therefore, SAPA fertilizer management practice with different hybrid varieties will produce more yield than other practices.

This study program provided the suitable practices of fertilizers management practices SAPA on growth and yield components of different maize varieties NK 621, NK 625 and SA 282 in Southern Shan State.

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