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The Effects of Combining NPK-20-10-10 with Urea on *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae) Attacks on Maize, and on Maize Growth and Yield Parameters in Njinikom (North West Cameroon)

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Abstract:

An experiment was carried out in Njinikom (North West of Cameroon), during the second maize planting season of 2005 and the first planting season of 2006; to investigate the effects of combining NPK 20:10:10 with urea in a maize cycle, on Busseola fusca (Fuller) (Lepidoptera: Noctuidae) attacks on maize and on maize growth and yield parameters. The experimental design used was randomized complete block with four replications. There were four treatments i.e. 1without fertilizer (control); 2 that received NPK 20:10:10 only at a rate of 200 kg/ha; 3 that received urea only at a rate of 40 kg/ha; and 4 that received a combination of NPK 20:10:10 at 200 kg/ha and urea at 40 kg/ha. There were significant difference between treatments for B fusca numbers and stem bored; treatment that received a combination of NPK and urea had the highest number of B fusca and highest level of stem bored. In both maize planting seasons, basal stem diameter, total plant height and cob width were significantly more for plots that received both NPK and urea. These plots with both NPK and urea applied had the tallest plant and the widest cobs, followed by the plots that received urea only. It is concluded that combining NPK 20:10:10 and urea increases B fusca incidence on maize. However since there was an increased in plant vigor (increased stem diameter and total plant height) the end effect was increased in yield parameters.

Key words: Urea, NPK 20:10:10 *Busseola fusca*, Maize, Season, Plots

Introduction

Until the late 1980s maize was considered by the majority of people as a crop solely for home consumption, rather than for revenue. Nowadays, maize could be found in weekly markets of the North West Region of Cameroon in general and in Njinikom in particular where it is sold in "tins", buckets or bags (Conte and Fussiler, 1993). According to estimate, traditional sector in the whole of Cameroon, produced a total of 466,000 tons in 1990-1991; the North West Region of Cameroon accounting for about 45% of this (Ayuk-Takem and Atayi, 1991). Maize is increasingly gaining importance as cash crop following the large decrease in price of some cash crop such as coffee. Many farmers in Cameroon in general, and the North West Region in Particular, now diversify their crop production because of the new trend in market forces as a result of local demand for maize to satisfy the need of the growing urban population, animal feed mills and other maize processing industries (Ndemah, 1999; Neba, 2006). This relative new trend has also been encouraged by large scale buyers such as MAISCAM (Maiseries du Cameroun), SCTM (Societe Camerounaise de Transformation de Cereal) etc (Conte and Fussiler, 1993). Furthermore, in Cameroon, maize has a wide range of uses namely: in the fresh state, it can be roasted and boiled; in the dry state (about 15% of water), the grains can be ground to produce flour that can use for the production of "fufu", for the production of pap for children and also biscuits. For a typical man from the North West Region of Cameroon, will generally not hesitate to admit that he feels he has not eaten at all if he has not had a Maize meal at least once a day. Industrially, the grains of dry maize can be used for the production of beer, and starch (Aroga, 2007; Ndemah, 1999). However large production

of maize in the North West Region of Cameroon in general and in Njinikom in particular is restricted by a number of factors, amongst which include: poor soil fertility and pests (Ndemah, 1999). Amongst the pests, insect *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae) is the most abundant and problematic in the region (Aroga, 1987; Cardwell et al., 1997; Schulthess et al., 1997; Borgemeister, 2002; Aroga, 2007). *B fusca* larvae feed on the aboveground parts of the maize causing economically important yield losses to the crops. Feeding and tunneling by *B fusca* larvae can result in the destruction of the growing point (resulting in dead hearts), interference with nutrients and metabolite translocation, resulting in the malformation of grains, stem breakage, plant stunting, and direct damage to ears (Unnithan, 1987; Harris and Nwanze, 1992; Kfir et al., 2002). Tunneling in host plant can predispose host plant to infections (Van Ransburg and Flett, 2008; Kendall et al., 2014)

Furthermore, due to the uniformly high human population in the North West Region of Cameroon and Njinikom in particular, a greater proportion of fields are not left to fallow any longer and the same piece of land is cultivated every year, leading to a sharp drop in soil fertility. Consequently, farmers in region (Njinikom) have reclined to use nitrogen based mineral fertilizers; some used urea only, others used NPK 20:10:10 only, while others combine the two i.e. NPK and urea. Some aspects on the effects of increased nutrients (fertilizers) on lepidopterous stem borer attacks on maize have been done in the humid forest ecological zone of Cameroon, and not in the Western Highlands (the North West Region) of Cameroon.

The objectives of this work are the following:

1. To investigate the effects of either NPK 20:10:10 or urea on maize infestation with *Busseola fusca* and on maize growth and yield parameters.

2. To investigate the effects of combining NPK 20:10:10 and urea on maize infestation with *Busseola fusca* and on maize growth and yield parameters.

Materials and methods

Study site

The study site was Njinikom in the North West Region of Cameroon. Njinikom is located at about latitude 06^0 12.628' N and longitude 10^0 17.540' E with an elevation of about 1100ma.s.l. Njinikom is characterized with heavy rainfall, with a rainy season that extends from March to mid November, while the dry season covers the rest of the months. The soil is humus, sandy and loamy in nature. Maize is planted twice a year. The first planting season extends from March to July while the second season extends from August to December.

Experimental design and layout

The experimental design used was randomized complete block design (RCB) with four replications, using different farmer's plots as replicates or blocks. The blocks were separated from each other by 300m to 800m. Each block was divided into 4 plots. A plot consisted of 10 eight metre ridges, spaced at 75 cm from each other. Each treatment was randomly assigned to a plot. The maize was planted during the last week of August in the second maize cropping season of 2005 (August to December) and during the last week of March for the first planting season of 2006. One of the maize plots was the control (i.e. no fertilizer was applied); one, NPK 20:10:10) at the rate of 200 kg/ha of compound fertilizer was applied; another, urea at the rate of 40kg/ha was applied; while in the remaining one plot both NPK 20:10:10 and urea at the rate of 200 kg/ha and 40 kg/ha respectively were applied. The treatments were separated from each other by 1.5 m. The maize variety used was the 150 days open pollinated Kasai and this was planted at the rate of four

grains per stand, with the stands spaced at 50 cm within ridge. The maize crops were thinned to two plants per stand, 14 days after planting (DAP). The NPK fertilizer was applied as side dressing 7 DAP; while the urea was applied at 28 DAP.

Sampling and data collection

Beginning 21 DAP, each maize plot was divided into four quadrants and four plants randomly sampled per quadrant, making a total of 16 plants per treatment. Each plant was dissected and observed for *B fusca* eggs, larvae and pupae numbers. The observations were done bi – weekly till green harvest. Additionally the basal stem diameter as well as the total plant height, percentage stem tunneled, cob fill, damage and cob width, length and weight were measured.

In February 2006, all the maize plots were ridged afresh and planted in the last week of March 2006, with maize (Kasai variety). All the maize plots were treated like the second season 2005 trials, and the agronomic practices were the same as in the 2005 trials.

Treatments

A summary of the 4 different treatments per block is given below:

Treatment	Description	Code
1.	Maize followed by maize	**MM**
2.	Maize followed by maize and NPK 20:10:10 applied	**MM-NPK**
3.	Maize followed by maize and urea applied	**MM-U**
4.	Maize followed by maize and with both NPK-20-10-10 and urea applied	**MM-NPK-U**

Statistical analysis

Analysis of variance (ANOVA) of plant, pest and damage and yield variables was carried out using the mixed model of SAS statistical analysis package (SAS Institute 2002). Treatment was considered as fixed effects while plants and quadrants were

used as random effects and the whole analyses done in repeated measures over sampling dates.

Results

Effect of fertilization on *B fusca* number and on plant damage (Presented in Tables 1 and 2)

In both seasons there were significant treatment effects on *B fusca* (DF=7, 4801; F=6.08; P<0.0001 for second season (S2) of 2005 and DF=15, 4330; F=2.38; P<0.0001 for first season (S1) of 2006). Plots where a combination of NPK 20:10:10 and urea were applied had the highest number of *B fusca* during both seasons (Table 1). In both seasons, there were significant treatment differences for stem bored (DF-7,986; F=6.89; P<0.0001 for S2 of 2005 and DF=15, 1030; F=2.10; P<0.0001 for S1 of 2006). The highest level of stem bored was observed in the plots that received a combination of NPK and urea. No significant treatment differences were observed for cob damage in both seasons (DF=7, 993; F=0.81; P=0.5821 for S2 of 2005 and DF = 15, 1026; F=1.28; P=0.2049 for S1 of 2006). (Table 2)

Effect of fertilization on plant, and yield parameter (Presented in Table 3)

In both maize planting seasons, there significant treatment difference for both the basal diameter (DF=7, 981; F=13.6; P<0.0001 for S2 of 2005 and DF=7, 1030; F=4.81; P<0.0001 for S1 of 2006) and total plant height (DF=7, 981; F=9.24, P<0.0001 for S2 of 2005 and DF=7, 1030; F=4.81; P<0.0001 for S1 of 2006). In the second season (S2) of 2005, there were significant differences between treatments for cob width (DF=7, 998; F=5.57; P<0.0001) while in S1 of 2006 there were no significant difference (DF=15, 1026; F=1.34; P=0.1700). In contrast, there were significant treatment difference for cob weight only during S1 of 2006 (DF=15, 1026; F=4.11; P<0.0001 for S1 of 2006, and DF=7, 986; F=1.05; P=0.3974 for S2 of

2005). No significant treatment difference was observed for cob length in both seasons (DF=7, 989; F= 1.23; P=0.02829 for S2 of 2005 and DF=15 1026; F= 1.51; P= 0.0958 for S1 of 2006). In both maize planting seasons, there were significant treatment differences for cob filled. Basal stem diameter, total plant height, cob width and percentage cob filled were significantly more for plots that received both NPK and urea. The plot with both NPK and urea applied had the widest and tallest plants, and the widest cobs and this was followed by the plots that received urea only.

Table 1: *B fusca* count during the second season (S2) of 2005 and first season (S1) of 2006.

Treatment	Season	
	S2	**S1**
MM	0.06aA	0.02aA
MM-NPK	0.07aA	0.03aA
MM-U	0.07aA	0.02aA
MM-NPK-U	0.08bB	0.04aB

- Values are those of the least square means(LSM)
- Means followed by the same upper case and lower case letters in the same column are not significantly different.

Table 2: Stem tunneling and cob damage during the second season of 2005 and first season of 2006

Treatment	Parameter	
S2	Stem bored(cm)	Cob damage (%)
MM	0.03aA	0.04aA
MM-NPK	0.02aA	0.02aA
MM-U	0.04aA	0.04aA
MM-NPK-U	0.06aB	0.03aA
S1		
MM	0.02aA	0.01aA
MM-NPK	0.01aA	0.02aA
MM-U	0.02aA	0.02aA
MM-NPK-U	0.03abA	0.02aA

- Values are those of the least square means(LSM)
- Means followed by the same upper case and lower case letters in the same column are not significantly different.

Table 3: Maize plant growth and yield parameters during the second season (S2) of 2005 and first season of 2006

Treatment	Parameters					
S2	Stem diameter (cm)	Total plant height(cm)	Cob width(cm)	Cob length(cm)	Cob weight(g)	Cob fill (%)
MM	1.58aA	142.26aA	4.05aA	11.06aA	150.15aA	0.87aA
MM-NPK	1.74bA	147.37aA	4.19aA	12.96aA	160.10aA	0.95bA
MM-U	1.81bA	144.76aA	4.10aA	11.38aA	160.11aA	0.90aA
MM-NPK-U	1.92bcA	156.77bA	4.60bA	12.94aA	170.37aA	0.96bA
S1						
MM	1.38aA	124.33aA	3.20aA	10.07aA	135.48aA	0.75aA
MM-NPK	1.40abA	123.56aA	3.54aA	10.98aA	128.37aA	0.83aA
MM-U	1.53bA	146.71bA	4.58aA	11.32aA	170.50bcA	0.92aA
MM-NPK-U	1.66bcA	147.21bA	4.60aA	11.73aA	190.93bcA	0.95bA

- Values are those of the least square means(LSM)
- Means followed by the same upper case and lower case letters in the same column are not significantly different.

Discussion

In both maize planting seasons, plots with both NPK 20:10:10 and urea applied had the highest number of *Busseola fusca* and the highest level of stem bored; which is in agreement with previous findings by Pimental, (1970) who pointed out that, " in general, well nourished plants are more susceptible to attack by insect and other pests". Plants that are well fertilized tend to be more attractive to insects and more vulnerable since well fed plants produce a large population of well fed insects. Setamou et al. (1993) found out that nutrient, nitrogen in particular had a positive effect on both plant growth variables, and the development and survival of stem borers. In the same light Ndemah et al. (2006), found out that stem borer infestation on maize were higher in plots that received fertilizers. They noted that, the most important factor related with *B fusca* abundance, plant damage and yield, is plant nutrients. They stated that, individual mineral nutrients do not only affect plant growth but they have a positive or negative effect on stem borer bionomics. Similarly, Setamou and Schulthess (1995) in surveys in maize

fields in Benin found a positive correlation between soil nitrogen and egg laid per plant by *Sesamia calamistis*. Some studies shows that, the female moth prefer to oviposit on host plant augmented with nutrients (Wolfson, 1980; Myer, 1985). Singler et al. (1988) showed that, oviposition preference and larval performance may be correlated, such that the females prefer plant species on which their larvae have the greatest chance of surviving during the first 10 days of growth. In the same line Jansen (1993) and Muhammad et al. (2013) noted that, the development and survival of larvae were lowest in treatment with zero nitrogen and larvae survived for a long time in plots with higher nitrogen doses. They stated that, the greater the nitrogen supply would amplify protein production and reduce the carbohydrate contents consequential in development of thinner cell wall and softening the tissues, which ultimately attract insects and damage by insects amplifies. From the above it may be inferred that, since increased in nutritional status of a plant increases plant vigor (increased in stem diameter, and total plant height), the increased in *Busseola fusca* in plots that received both fertilizers can be attributed to: easier penetration of softer tissues of rotund and robust stem of well fed plants. Furthermore, it can be as a result of the ability of the larvae of insect to completely embed itself in the stem because of increased girth, and became shielded completely from entomophagus parasites and predators.

In both seasons, there were significant treatment differences for basal diameter, total plant height and percentage cob filled. In both seasons, plots where a combination of NPK 20:10:10 and urea applied had the tallest and widest plants, and in addition the widest and well filled cobs. This was followed by plots that receive plots that received urea only. Though the nutritional analyses for treatments were not done, it can be hypothesized that treatment greatly contributed a high amount of nutrients to the maize resulting

in increased plant vigor and consequently increased in both plant growth and yield parameters. Chabi-Olaye *et al*. (2005) stated that an increased in nutritional state of plants enhance both borer fitness, and plant vigor (increased stem diameter, increased total height) but with an increased net benefit of the plant i.e. (cob length, cob width, cob weight and percentage cob filled.

Conclusion

The results of this work show that, combining NPK 20:10:10 with urea during maize cycle increases the incidence of *Busseola fusca* attacks on maize. However, since there was also an increased in plant vigor (stem diameter, and total plant height), the end effect was increased in yield parameters (cob width, cob length and filled cobs). Combining NPK with Urea is a better method of fertilizer application. Even though the incidence of *B fusca* was higher in plots that receive the combine fertilizer; maize plants in these plots had a higher vigor, which still resulted in an increased in yield parameters.

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