# Effect of Fertilizers on Productivity of Corn-Soybean Rotation

Karlyga Karayeva, and Rakhimzhan Yeleshev

***Abstract*- Fertilizers are a powerful control instrument for plant products. The experiment was conducted during the 2013-2014(2014) and 2014-2015(2015) growing seasons on a meadow chestnut soil at the experimental station "Agrouniversity" of the Kazakh National Agrarian University of Almaty in Kazakhstan to evaluate the effect of macro fertilizers and micro fertilizers application on yield and quality by corn-soybean intercropping. It has been established that high nitrogen doses are increased the yield of green mass of corn, have some negative impact on the accumulation of green mass of soya. The positive effect on the formation of the green mass of soya provided mineral fertilizer with micro fertilizers.**

**Key words----corn-soybean intercropping, macro and microfertilizers, NPK, yield**

## I. Introduction

The key trends of stable agribusiness industry development in Kazakhstan involve working on new high-performance agricultural technologies in terms of cultivation of nonconventional crops ensuring increase in their productivity with simultaneous soil conservation and reproduction. One of the most important ways to solve the problem of increasing the production of plant proteins is to expand the area of mixed crops of corn with soybeans for silage, providing reception of protein-rich fodder and not require additional costs to the cultivation. The possibility for co-cultivation of corn with soybean in Kazakhstan proved a number of studies. Fertilizer is a power of plant, which affects their growth, development and productivity, the accumulation of substances in biophilic reproductive organs. Macro and micronutrients increase productivity and quality of products. In metalloenzymatic plant complex zinc plays a catalytic role [1]. The physiological role of zinc in plants is closely linked to its participation in the nitrogen regime. Zinc deficiency in nutrition of higher plants leads to a significant reduction of protein content and the accumulation of soluble non-protein nitrogen compounds: amides and amino acids. Zinc increases the amine content and protein nitrogen in cereals [2]. In modern agriculture to improve the quality of soybean increases the value and the use of microelements. Molybdenum is particularly important role in nitrate reduction, aminoacides and protein biosynthesis and in symbiotic nitrogen fixation apparatus molecular soybean. Soybean is the most important oilseed culture.

Manuscript received March. 02.03. 2016.

K.O. Karayeva is with the Kazakh national agrarian university, Abay ave. 8, Almaty, Kazakhstan

R.E. Yeleshev was is with the Kazakh national agrarian university, Abay ave. 8, Almaty, Kazakhstan

It is known that the data on the influence of molybdenum on the fat and protein content in the grain positive.

There are several management concerns that growers should consider beforemixing corn and soybean grown for forage:

- Optimum planting date for corn is slightly earlier than that for soybean.
- Matching corn hybrids and soybean varieties, planted on the same date, so that both reach optimum maturity for forage harvest at the same time may be difficult. (Soybeans should be at full bean pod, R7, and corn or near 1/2 to 3/4 kernel milkline stage to maximize forage yield and quality).
- Weed control may be difficult, unless weed species present can be controlled mechanically or with herbicides which are compatible with both crops.

Usually, the relatively small increase in protein concentration with corn/soybean intercropping will likely not offset the forage yield decrease compared to monocrop corn, especially given the management difficulties that may be encountered. An alternative way to increase forage protein content is to plant one-half the field to each crop and chop one row of each per round to mix while chopping. This would likely result in greater increases in forage protein content that intercropping corn and soybean, but forage yields per acre for the field would be about 30% lower than for corn grown alone. In most situations, protein levels in rations including corn silage could be increased more effectively by adding protein supplement using soybean meal or whole soybean at feeding time [3].

Since the expenses of feeding animals can beeven 70% of all production costs, reducing expenses in feed production is important for improving the profitability of livestock producers. Above ground biomass of maize and soybean grown in mixtures has extremely high nutrition value, and in the future this mixture could be a very important ingredient in livestock nutrition, especially as silage. There are many advantages to this kind of intercropping production: keeping and improving major characteristics of soil and increasing quality silage production. Noticed that maize is a plant that with proper ensiling techniques produces high quality and stable silage. The same authors claimed that one of the disadvantages of leguminous plants is that they are hard to conserve by ensiling, because of a small amount of fermentable sugar. Silage made of mostly leguminous crops has a smaller amounts of milk-acid and because of that, the pH value of such silage is higher. At the same time, proteins and amino-acids decompose, leading to deterioration of silage. For these reasons, it is difficult to produce good quality silage made only of leguminous crops.

On the other hand, a drawback of silage made only of maize is that such feed has mostly carbohydrates and less proteins [4]

## II. Materials And Methods

The study was conducted at the "Agrouniversity" Experimental Station of the Kazakh National Agrarian University, located in the northwestern part of the Enbekshi-Kazakh area of the Almaty region, 37 km from Almaty and 18 km from Issyk, Kazakhstan during the 2009 and 2011 growing seasons. The site lies at longitude 43º28´59.93´´C and latitude 77º19´16.03´´B. The climate of the study area is characterized as strongly continental with an average annual rainfall of 350-420 mm. During the growing season, the precipitation ranges from 120-300 mm. The study area is located in a foothill desert-steppe region with elevations of 550-700 meters above sea level. This region is crossed by a several mountain rivers and streams. Ground water is located at a depth of 1.2-1.6 m. in many parts of this region and currently is an economic source of irrigation water.

The soils at the study site were a meadow chestnut soil with pH =7,8, organic matter, total phosphorus, total nitrogen contents of 4.38, 0.19, and 0.221 %, respectively. Soil parent materials are loamy loess deposits underlain by gravelly deposits. The plots were arranged in a randomized complete block design with three replications. The area of the plot was 56 $m^2$. The soil and plant analytical methods used in this study are shown in (Tabl 1).

TABLE I: ANALYTICAL METHODS USED FOR THIS STUDY

| Analysis | Method |
|---|---|
| **$NO_3$-N** | Colorimetric disulfonic acid method of Grandval-Ljazhu |
| **Organic matter** | Method of Tyurin |
| **Soluble P** | 1% ammonium carbonate extract method of Machigin |
| **Soil moisture** | Gravimetric |
| **Oil content** | By Soxlet apparatus |

In the experiment cultivated soybean – variety Nena (Serbia) (seeding rate of 200 thousand units / ha) and corn hybrid Tulpar 539 (Kazakhstan) (seeding rate of 60 thousand units / ha).

TABLE II: THE SCHEME OF FERTILIZER APPLICATION UNDER CORN-SOYBEAN INTERCROPPING CROPS

| **Fertility Treatment** | **Terms of use of fertilizers** | | | | | | |
|---|---|---|---|---|---|---|---|
| | Under the basic soil cultivation | | | Before sowing | | | The additional fertilizing |
| | N | $P_2O_5$ | $K_2O$ | N | Mo | Zn | N |
| | | (kg/ha) | | | (kg/ha) | | (kg/ha) |
| **Control** | - | - | - | - | - | - | - |
| **$N_{60}P_{60}K_{60}$** | | 60 | 60 | 60 | | | 60 |
| **$N_{60}P_{60}K_{60}$+$Mo_{1.5}$** | | 60 | 60 | 60 | 1.5 | | 60 |
| **$N_{60}P_{60}K_{60}$+$Zn_{2.5}$** | | 60 | 60 | 60 | | 2.5 | 60 |
| **$N_{60}P_{60}K_{60}$+ $Mo_{1.5}$+ $Zn_{2.5}$** | | 60 | 60 | 60 | 1.5 | 2.5 | 60 |
| **$N_{120}P_{120}K_{120}$** | | 120 | 120 | 60 | | | 60 |
| **$N_{120}P_{120}K_{120}$+$Mo_{1.5}$** | | 120 | 120 | 60 | 1.5 | | 60 |
| **$N_{120}P_{120}K_{120}$+$Zn_{2.5}$** | | 120 | 120 | 60 | | 2.5 | 60 |
| **$N_{120}P_{120}K_{120}$+ $Mo_{1.5}$+$Zn_{2.5}$** | | 120 | 120 | 60 | 1.5 | 2.5 | 60 |

As shown in the table, phosphorus-potassium fertilizers were applied in the autumn under the basic soil cultivation, nitrogen- ½ of the annual rate and micronutrients in the spring before planting as additional fertilizing. As nitrogen fertilizer ammonium nitrate (34% N); phosphorous- ammophos (46% P2O5), potassium - potassium chloride - 56% K2O and microfertilizers- ammonium molybdate (52% Mo), zinc sulfate (22% Zn).Statistical analysis of the data was performed by using the ANOVA procedure in SAS, version 9.2 (SAS Institute, Inc., Cary, NC).

## III. Results And Discussion

The data show that the application of macro and micronutrients increase the total yield of green mass of corn-soya intercropping and improve its quality.

On the control the overall yield of silage amounted to an average of 2 years 515.0 q/ ha. On fertilized treatments silage yield was within 619.4-775.4 q / ha. Addition of fertilizer was within 104.4-260.4 q / ha (Table 3).

TABLE III: EFFECT OF FERTILIZERS ON PRODUCTIVITY OF CORN-SOYBEAN INTERCROPPING ( 2014-2015)

| Fertility Treatment | Yield of green mass q / ha | | | Addition to yield | |
|---|---|---|---|---|---|
| | 2014 | 2015 | averages for 2014-2015 | q / ha | % |
| **Control** | 504.3 | 525.8 | 515.0 | - | - |
| **$N_{60}P_{60}K_{60}$** | 584.7 | 654.1 | 619.4 | 104.4 | 20.2 |
| **$N_{60}P_{60}K_{60}$+ $Mo_{1.5}$** | 632.5 | 725.9 | 679.2 | 164.2 | 31.8 |
| **$N_{60}P_{60}K_{60}$+$Zn_{2.5}$** | 690.8 | 710.5 | 700.6 | 185.6 | 36.0 |
| **$N_{60}P_{60}K_{60}$+ $Mo_{1.5}$+ $Zn_{2.5}$** | 730.8 | 820.1 | 775.4 | 260.4 | 50.5 |
| **$N_{120}P_{120}K_{120}$** | 700.0 | 687.4 | 693.7 | 1787 | 34.6 |
| **$N_{120}P_{120}K_{120}$+$Mo_{1.5}$** | 695.8 | 736.8 | 716.3 | 201.3 | 39.0 |
| **$N_{120}P_{120}K_{120}$+$Zn_{2.5}$** | 702.7 | 754.6 | 728.6 | 213.6 | 41.4 |
| **$N_{120}P_{120}K_{120}$+ $Mo_{1.5}$+ $Zn_{2.5}$** | 721.3 | 795.1 | 758.2 | 243.2 | 47.2 |

The greatest yield of corn-soybean intercropping for 2 years (775.4 kg / ha) was obtained with the combined application of micronutrients with $N_{60}P_{60}K_{60}$. The data in Table 2 also show the high efficiency of mineral fertilizers separately introduced microfertilizers on mixed crops of corn and soybeans. Application of macrofertilizers with separately introduced microfertilizers received addition to yield of green mass within 164.2-213.6 q / ha compared to control. Mineral fertilizers provides silage productivity an average of 2 years 619.4-693.7 q / ha.

The results showed that the application of macro and microfertilizers providing a positive impact on the overall yield of silage and has its own characteristics impact on the formation of the yield of the individual components of the intercropping. High nitrogen doses increase the yield of green mass of corn and have some negative impact on the accumulation of green mass of soybean. The positive effect on the formation of the green mass of soybean provided mineral fertilizer with microfertilizers. However, with the right mix of fertilizers can reduce some negative effects of nitrogen fertilizer on soybean and thereby improve the yield of corn-soya intercropping.

Great value has the identification of changes in forage quality silage (protein, fat) under the joint cultivation of corn and soybeans at entering various fertilizer systems.

TABLE IV: INFLUENCE OF FERTILIZERS ON FORAGE QUALITY OF THE GREEN MASS OF CORN-SOYBEAN INTERCROPPING, % ON DRY MATTER ( 2014-2015)

| Fertility Treatment | Crude protein% | Fat % | Cellulose % | Phosphorus % | Calcium % |
|---|---|---|---|---|---|
| **Control** | 7.75 | 0.9 | 27.0 | 0.2 | 0.3 |
| **$N_{60}P_{60}K_{60}$** | 9.8 | 1.1 | 27.3 | 0.3 | 0.3 |
| **$N_{60}P_{60}K_{60}$+ $Mo_{1.5}$** | 11.0 | 1.6 | 26.9 | 0.3 | 0.2 |
| **$N_{60}P_{60}K_{60}$+$Zn_{2.5}$** | 12.5 | 1.5 | 29.1 | 0.2 | 0.4 |
| **$N_{60}P_{60}K_{60}$+ $Mo_{1.5}$+ $Zn_{2.5}$** | 14.0 | 1.8 | 28.4 | 0.3 | 0.5 |
| **$N_{120}P_{120}K_{120}$** | 12.5 | 1.6 | 28.6 | 0.2 | 0.3 |
| **$N_{120}P_{120}K_{120}$+$Mo_{1.5}$** | 12.0 | 1.7 | 27.8 | 0.3 | 0.4 |
| **$N_{120}P_{120}K_{120}$+$Zn_{2.5}$** | 13.0 | 1.6 | 29.5 | 0.4 | 0.4 |
| **$N_{120}P_{120}K_{120}$+ $Mo_{1.5}$+ $Zn_{2.5}$** | 13.5 | 2.0 | 30.1 | 0.3 | 0.3 |

Certain interest is the balance of digestible protein in the fodder mass, the amount of digestible protein corresponding to 1 fodder unit. It is known that in the corn crop in the milk-phase waxy and silage prepared therefrom by one fodder unit has to 50-60 g digestible protein [5]. Quality of the crop is the chemical composition of the resulting weight of the product, for which crop growers. For some this cultural protein content for others, fat, fiber, etc. [6]. Depending on the conditions of cultivation of crude protein content in pure corn during the milk-wax ripeness varies between 6.0-8.0% without the use of fertilizers and fertilizer at 9.0-11.0% [7-10].

In terms of our experience with the joint cultivation of corn with soybean protein content of the forage increased from 7.75% in the control and to 9,8-14,0% in the fertilized variants. Importantly, in the cultivation of corn with soybean the fat content of the fertilizer is significantly increased the contents of fat, phosphorus, calcium and other components. The data in Table 4 show that the fertilizer significantly increases the percentage of cellulose, phosphorus and calcium in the composition of green mass of corn-soybean intercropping. On the average for 2 years from the use of fertilizers the content of phosphorous increased by 0.1-0.2%, protein-2.02-6.25%, calcium, 0.1-0.2% compared to control. The amount of cellulose in the silage mass from the use of fertilizers increased slightly. Mineral fertilizers with zinc unlike mineral fertilizer with molybdenum have little effect on the fat content of the forage. Thus, the fat content with the introduction of zinc fertilizer ranges from 1.5-1.6% as against

0.9% in the control, while its content in the silage mass increased significantly (to 1.6-2.0%) at application of mineral fertilizers and molybdenum. Adding zinc sulfate has a positive effect on the crude protein content.

## IV. CONSLUSION

Thus, the studies have shown that in conditions meadow-chestnut soils irrigated foothills southeast Kazakhstan area high productivity of corn-soya intercropping with good fodder quality provides the introduction of a joint with $N_{60}P_{60}K_{60}$ microfertilizers (Zn, Mo), as well as with the use of $N_{120}P_{120}K_{120}$ microfertilizers. Adding macro- and micronutrients under the joint cultivation of corn and soybeans increases the content in the green mass of protein 2.02-6.25%, phosphorous- 0.1-0.2%, fat- 1.5-2.0% and calcium - 0.1-0.2%.

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