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# Effect of Intercropping of some Legume Forage Crops with Maize Under Levels of Mineral Npk and Nano Npk Fertilizer

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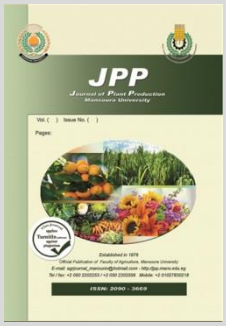


## ABSTRACT

A field experiment was carried out at Mallawi Agricultural Research Station, Minia Governorate, ARC, during two successive summer seasons of 2017 and 2018 to study the effect of intercropping three fodder crops on productivity, quality and profitability of maize cv. Giza 168 and using different rates of NKP nano + mineral fertilizer. A complete Randomized Block Design in a split plot arrangement with four replicates was used in both seasons. Main plots were devoted for the following three fodder crops guar, cowpea and cilitora 50% of the recommended. The following rates of fertilizer , 100 % NPK mineral fertilizer, 100% NPK nano fertilizer,75% nano+25% mineral fertilizer, 50% nano + 50% mineral fertilizer and 25 % nano+ 75% mineral fertilizer added for maize from recommended does were allocated in the sub-plots. The highest values of these characters were obtained with 75% nano fertilization NPK + 25% mineral fertilization NPK fed$^{-1}$. Maize grain yield could be noted from the combined analysis that the yield of grain (ardab/fed) was representing 3.07, 9.71.18.11.8.95 and 8.81% of pure stand of maize, respectively. The percentage of protein, phosphorus and potassium in maize grains increased in percentage compared to the individual in both seasons and combined. Intercropping cilitiora with maize and using 100 % mineral fertilizers recorded the lowest values for (LER& ATER). Net return of intercropping cowpea with maize and using rate 75% nano and 25 % mineral fertilizer 8589.4L.E. fed-$^{1}$ an average of the two successive seasons.

***Keywords:*** nano fertilizer, cilitiora, NPK, guar, intercropping and mineral.

## INTRODUCTION

Nano fertilizers are being studied as a way to increase nutrient efficiency and improve plant nutrient, compared with traditional fertilizers. It is an innovative agricultural inputs which are aimed to release nutrients into the soil gradually in a controlled way, thus avoiding environmental damages and improving the crop growth and productivity would achieved (Sekhon, 2014 and Suppen 2017).Nano active ingredients, which are 1–100 billion of meter (nm) in diameter, have a large specific surface area that can result in an acceptable reactivity, and this feature increases effective absorption of nutritional elements and essential components for plant growth and plant metabolism (Meena *et al.,* 2017). In nano fertilizers, nutrients can be encapsulated by nano materials, coated with a thin protective film, or delivered as emulsions or nano particles (DeRosa *et al.,* 2010). In a new type of nano fertilizers, the nutrients can be released in response to environmental factors. It seems that nano fertilizers could be able to release nutritional elements in a controlled manner (slowly or quickly) in reaction to different environmental fluctuations such as temperature, moisture and soil acidity, so it can enhance plant growth more effectively compared with traditional fertilizers (Hediat *et al.,* 2012). However, in traditional type most of the utilized fertilizers are rendered unavailable to crops due to various reasons, such as hydrolysis, leaching, decomposition and degradation by photolysis. Consequently, it is essential to reduce nutrient losses in fertilization and to increase nutrient use efficiency through the application of "smart nano fertilizers" (Siddiqui *et al.,* 2015). It appears that nano fertilizers provide the nano scale or nano structured nutrients in a controlled-release and lead to an increased efficiency of the nutrients, diminish the toxicity of the soil, improve nutrient use efficiency and decrease costs of environmental protection (Sekhon, 2014, Rameshaiah *et al.,* 2015).

Ehteshami *et al.* (2007) found that maize qualitative and quantitative characteristics were significantly increased by phosphate-solution microorganisms; which increased the growth and resistance of plants in water deficit conditions. Although macronutrients supplied in the form of traditional NPK fertilizers, so it could improve growth compared with control, the effect of nano-chelated micronutrients was much more impressive Nonmaterial could to be applied in designing more soluble and diffusible sources of NPK fertilizer for increasing plant productivity. (Moore, 2006, Navarro *et. al.,* 2008, Rameshaiah1 *et al.,* 2015 and Anjuman *et. al.,* 2017).

Eleyan Sohair *et al.,* (2018 ) studied two application methods (foliar and soil on cotton ) and four application rates of control [100% soil application traditional recommended NPK fertilizer dose (RFD)] and nano NPK fertilizers (12.5%, 25% and 50% of RFD). Foliar NPK nano-fertilizers application of all traits recorded higher values of all studied parameters than soil application. Nano fertilizers at 50% RFD recorded values on par with traditional (100% RFD) for the studied characteristics and parameter. Treatments of 12.5% were on par with RFD 25% NPK nano fertilizers for the most studied growth parameters. The highest values of the previous traits were obtained from plots treated with 50% RFD nano NPK with

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split 3 times and foliar application in most cases. This means that nano NPK fertilizers particles reduces consumption, loses, negative impacts of environment and increase nutrient uptake efficiency.

Nano-fertilizers have high surface area, absorption capacity, and controlled-release kinetics to targeted sites, and have been considered as smart delivery system. In agricultural systems, nanotechnology can increase crop growth and save energy, to promote better and more economic food production. Spraying nano-fertilizers requires lesser amounts and has lower cost that chemical fertilizer. Nanotechnology is a promising field of interdisciplinary research. The potential uses and benefits of nanotechnology are enormous. A large proportion of those living in developing countries face daily food shortages as a result of environmental impacts. For developing countries, the drive is to develop drought and pest resistant crops, which also maximize yield. The application of nanotechnology to agriculture and food industries is also getting attention now days (Moore 2006, Navarro *et. al.,* 2008 and Rameshaiah *et al.,* 2015).

Maize (*Zea mays*), which is the third most important cereal crop in the world, is an important dual purpose crop used in human diet and animal feed. Maize has the potential to supply large amounts of energy-rich forage for animal diets, and its fodder can safely be fed at all stages of growth without any danger of oxalic acid, Thus, forage maize has become a major constituent of ruminant rations in recent years, where its inclusion in dairy cow diets improves forage intake, increases animal performance and reduces production costs. Cowpea (*Vigna sinensis*), an annual legume with high level of protein (about twice times more than maize), can be mixed with maize to improve forage protein content of diets and, thus, the costs of high quality forage production can be lowered (Anil *et al*., 1998; Ahmed *et al.*, 2015, Myaka 1995 and Carpici *et al.* 2010) .

Intercropping has been identified as a promising system that results in an effective use of land and other resources (Remison.1982). Efficient cultivation of water and soil nutrients and reduction in the cost of production (Sharma *et al*., 1993 and Toaima *et al.,* 2004) . Intercropping systems provide greater potential than monoculture for sustained production and income. Intercropping cowpea with maize depressed cowpea yields, while maize yield was higher in the intercropping system (Sharma *et al.,* 1993 and Ocaya *et al.,* 2001). Sing and Kaushik (1987). Gangware and Sharma(1994) indicated that intercropping maize with guar increased total yield as associated crops and total income, compared to both as sole crop. Toaima (2006 ) intercropping cowpea and guar system of 100 % maize +37.5 % recorded cowpea or guar gave the highest values. Whereas the lowest values were recorded by100% maize + 12.5% cowpea or guar. Land Equivalent Ratio (LER) was significantly higher at the ratio of 100% maize +37.5 cowpea or guar. Ali and Atif (2011) intercropping between Rhodes grass and Clitoria were used in this study. It was significant ($P \leq 0.05$). For fresh and dry forage yield in all the three cuts for five treatments, the range of the forage yield was 46.83 to 62.66 t\ha for fresh yield and 6.11 to 7.3 t\ha for dry yield. The range of crude protein was 12.25 to17.50 for the third cut. Awad (2019) the effect of a cereal (Sudan grass) intercropped with leguminous (Cilitoria) forage under saline arid environment. Intercropping of Clitoria with Sudan grass significantly increased both fresh and dry forage yields compared to sole crop during both seasons.

The objective of this research was to study the response of summer Legume fodder crops i.e. , guar , cowpea and clitiora to intercrop with maize and applied fertilizer nano fertilizer (NPK)particles does for achieving success under intercropping conditions on the yield and its components under Middle Egypt conditions.

## MATEREALS AND METHODS

The experiment field was conducted at Mallawi Agricultural Research Station, Minia Governorate, ARC, during two summer seasons 2017 and 2018. Maize cv. Giza 168 (yellow corn), cowpea (*Vigna unguiculata*) , guar (Cluster bean) *Cyamposis tetragonoloba* and clitoria ( butterfly pea) *Clitoria Ternatea*. These experiments were laid out in split – plot arrangement using Randomized Complete Blocks design with three replicates. The sub – plot area was 24 $m^2$ consisting of 5 beds, each of bed was 120 cm in width and , 4m in length.

The main plots were devoted to the three intercropping fodder crop legume, guar, cowpea and clitoria with maize.

A1- 100% maize +50% guar from recommended.
A2- 100% maize +50% cowpea from recommended.
A3- 100% maize +50% clitoria from recommended.

The sub plots were occupied the Levels of mineral and nano particles of NPK fertilization.

F1- 100% mineral fertilizer NPK of maize from recommended.
F2- 100%Nano particles NPK fertilizer of maize from recommended.
F3- 75% Nano particles NPK + 25% mineral NPK fertilizer of maize from recommended.
F4-50% Nano particles NPK + 50% mineral NPK fertilizer of maize from recommended.
F5- 25%Nano particles NPK + 75% mineral NPK fertilizer of maize from recommended.

Solid plots of maize and three fodder crop legume, guar, cowpea and clitoria were also included in each replication for comparison and determination of the competitive relationships and to calculate the yield advantage of crops, total income and net return $fed^{-1}$. Maize was planted on two sides of beds and one plant/ hill at 25cm apart in all intercropping patterns. The three fodder crops legume were planted on the center of the bed and two plant / hill at 20 cm between hills for the intercropping systems. Maize plants and the three fodder crops were planted one side of ridges as pure stand. Legume crops were planted with sowing maize plants.

Plants were sowing on May 25$^{th}$ and 28$^{th}$ in 2017 and 2018 seasons, respectively. The preceding crop was wheat in both seasons. Normal cultural practices were applied for each crop under study either in pure stand or in intercropping as recommends for the region. However, nitrogen fertilizer was applied as ammonium nitrate (33.5%N) at a rate 100 kg N $fed^{-1}$.in three equal doses jest before the first, second and third irrigation of maize. Calcium super phosphate (15%$P_2O_5$) at a rate of 150 kg

$fed^{-1}$.was added during preparations the land for sowing. Potassium fertilizer was applied before sowing (during seeded preparation) at rate of 50 kg/fed., in the form of potassium sulphate (48%$K_2O$). All other agricultural practices for maize and legume fodder crops production was carried out as recommended by the Ministry of Agriculture.The nitrogen fertilizer for sole planting of guar, cowpea and clitiora crops was added at 25 kg N after the first and second irrigations. Seed rate per acre for each Guar 10 kg/fed, cowpea 30 kg/fed and clitiora 25kg/fed. Nano- compound namely: Hyper feed motawazen 19:19:19 NPK (Bio nano tech for fertilizers development) at 10 kg / fed added as foliar application at two times i.e., after 30 and 45 days from sowing. Nano technology fertilizers namely (Total nitrogen N 19%,$P_2o_2$ phosphor 19%, potassium $k_2o$ 19%, Fe 0.48%, Mg 0.80%, Mn 0.24%,Zn 0.35%,B 0.05%, cu 0.08%, Amino acids 1.15%, Algae Extract 0.52 %, Mo 100% and PPm co 100ppm.

The recorded data of maize, plant and ear height were measured as the average of ten plants and ear / plot at harvest after 110 days from sowing. At harvesting: ear length and diameter, no of row/ear, weight of grain $ear^{-1}$ , weight of 100 – grains and grain yield ardab $fed^{-1}$. (ardab = 140kg). For legume fodder crops plant height (cm), fresh, weight /plant (g),dry weight/ plant(g),total yield /fed(ton) and total dry yield/fed(ton).total fresh and dry yield / fed.(ton) were calculated for all plots.

The legume fodder crops intercropped with maize were cut once after; while solid plots had were two cutting after 60 days of seeding and the second after 45 days from the first.

**Chemical analysis:**

Maize seeds were carefully cleaned and freed from dirt, stones, chips and other extraneous material, then ground to pass through a 0.4mm screen for proximate analysis. Nitrogen, protein (nitrogen% x 6.25), phosphorus and potassium determined according to AOAC (2000).

**Competitive relationships and yield advantages**:

**1- Land Equivalent Ratio (LER)** was calculated estimated according to *(Willey 1979)* using the following formula:

**LER = yab/ yaa + yba / ybb**

**Where: Yaa = pure stand yield of species a (maize).**
**Ybb= pure stand yield of species (b).**
**Yab = mixture yield of a (when combined with b)**
**Yba = mixture yield of b (when combined with a).**

**2- Area Time Equivalent Ratio (ATER**): Area time equivalent ratio provides more realistic comparison of the yield of intercropping over monocropping in terms of time taken by component crops in the intercrop according to Hiebsch and McCollum (1987 a &b) . Also we used the method utilized by *Hiebsch (1980)* ATER was calculated by formula area time equivalent ratio.

**ATER= (LERb x DCb+ LERa x DCa) Dt**

**Where: LER is land equivalent ratio of crop, DC is duration (days) taken by crop, Dt is days to intercropping system from planting for harvest.**

**3- Competitive ratio (CR)** was calculated by the following formula as given by Willey and Rao (1980).

**CR = CRa + CRb**

**CRa = LERa / LERb X Zba/ Zab**

**Where: LERa and LERb represent relative yield of a and b intercrops, respectively. Since the CR values of the two crops will in fact be reciprocals of each other. CRa, CRb are the competitive ratio for (a) and (b) intercropping.**

**4- Aggressivity (Agg):** This was proposed by Mc-Gilichrist (1965) and was determined according to the following formula:

**Aab = Yab / yaax zab - Yba/ ybb x zba.**

An aggressivity value of zero indicates that the component crops are equally competitive. For any other situations both crop will have the same numerical value but, the high of the dominant crop is positive and the dominated is negative. The greater numerical value of (Agg), gave greater difference in competitive abilities and hence the larger the difference between actual and expected yield. Where Zab representing the sown proportion of intercrop a (guar, cowpea and cilitiora) in combination with (maize) and zba the sown proportion of intercrop a (maize) in combination with b (guar, cowpea and cilitiora).

**5- Monetary advantage index (MAI):** Suggests that the economic assessment should assessed on the basis of the rentable value of this land . MAI was calculated according to the formula suggested by Willey (1979).

**MAI= Value of combined intercrops x LER-1/LER**

**6- Farmer's benefit**: It was calculated by determining the total costs and net return of intercropping culture as compared to recommended solid planting of maize as follows: Total return of intercropping cultures = Price of maize yield + price of intercropping pattern yield. To calculate the total return, the average of cowpea, guar and cilitiora prices presented by Agriculture Statistics (2016 and 2017) seasons was used.

Net return per fed. = Total return – (fixed costs of maize + variable guar, cowpea and clitiora according to intercropping pattern). L.E 480 for ardab of maize; LE 300 for ton of guar, cowpea and clitiora.

**- Statistical analysis:**

All data were statistically analyzed using analysis of variance (ANOVA) with the Statistical Analysis System MSTAT–C Statistical Packing (Freed 1991). Probabilities equal to or less than 0.05 were considered significant. If ANOVA indicated differences between treatment means LSD test was performed to according to (Steel and Torrie 1980). Bartlett test according to (Bartlett,1937)was done to test the homogeneity of error variance. The test was not significant for all assessed traits, so, the two season's data were combined.

**Table 1. Some physical and chemical properties of the soil at depth of 0-30 cm during 2017 and 2018 seasons.**

| Properties | Sand % | Silt % | Clay % | pH | ECe | CaCo3 % | O. M % |
|---|---|---|---|---|---|---|---|
| 1st season | 9.57 | 37.83 | 51.36 | 7.86 | 1.73 | 1.80 | 1.60 |
| 2nd season | 10.39 | 39.26 | 48.66 | 7.84 | 1.76 | 1.74 | 1.66 |
| Soil texture | | | | | | | |
| Salty clay loam | | | | | | | |
| Available nutrient | | | | | | | |
| | N % | | P ppm | | K mm | | |
| 1st season | 0.19 | | 20 | | 350 | | |
| 2nd season | 0.19 | | 22 | | 370 | | |

**E.C = Electric conductivity (ds/m, 1:5 soil water extract). O.M= Organic matter**

## RESULTS AND DISCUSSION

**1- Maize**

**A-Effect of intercropping legume fodder crops on maize:**

The tabulated results in Tables (2&3) indicated that intercropping of guar, cowpea and clitiora with maize had a significant effect on grain/ plant (g) in the 1st seson and combined, stem and ear diameter (cm). in the 2nd season and combined , ear weight (g) in the combined . On the other hand plant height, ear height, ear length ear rows grains/row (no), 100 grain (g), % ears/plant and yield ardab fed $^{-1.}$ in the 1st season, 2 nd season and combined were not significantly affected by intercropping with maize .

Intercropping clitoria with maize gave the highest values of grain yield (25.68 & 30.49 ardab/fed$^{-1}$ ) in 1st and 2 nd seasons, respectively, whereas guar intercropping with maize gave the lowest values of grain yield (22.52&28.45 ardab/fed$^{-1}$) in the both seasons.

The reduction in the growth of cowpea and guar was due to increased shading from the maize plants especially when cowpea was introduced at the fourth week. A study by (Toamia 2006 and Myaka 1995) showed that the time of introducing cowpea and guar in intercropping system had significant effect on canopy height of crops across seasons and locations. Early growth of cowpea together with maize led to high cowpea canopy formation. Planting the two intercrop components the same day gave the highest maize grain yield. Myaka (1995) reported that yield of cowpea was not significantly different when sown with maize or two weeks after maize, while yield was 67% lower when sown four weeks compared with two weeks after maize. Due to the small size of the total vegetation of clitoria plants compared to the total vegetation of both cowpea and guar plants and the slow growth of clitoria, this led to a lack of competition for water and food with maize plants, which led to an increase in the maize crop, which was loaded with the fodder crop.

Pure stand or sole maize gave 23.40 & 24 ardab fed $^{-1}$ in the both seasons respectively. Tied of solid plants of maize were inferior to all intercropped treatments. It could be noted from the combined analysis (Table 3) that the intercropped cowpea, guar and clitiora with maize was recorded 7.55,10.68 and 18.48 % of pure stand of maize gave grain yield, respectively. Shorter intercropping period allows grain maize to grow for a longer period free from inter competition. Hence, it will have better growth resources ultization and higher photosynthesis potential resulting in better assimilates production and distribution to ears. That will lead to, as previously mentioned, higher ear and grain weight, which will, finally, increase grain yield *(*Ahmed *et al.*, 2015).

**Table 2. Yield traits of intercropped maize with guar ,cowpea , and clitora as affected by NPK different rates of mineral and NPK nano fertilizer in 2017 and 2018 cropping seasons .**

| Interc. roppin Patter. (A) | Rate Fertilizer (B) | Plant height (cm) | Stem dime. (cm) | Ear Height (cm) | Ear | | | No grain row | Weight ear (g) | Grain yield /plant (g) | 100 weight Grain (g) | No. of ears /plant | Grain yield Ardab fed$^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Length (cm) | Rows (N0) | Dimater (cm) | | | | | | |
| 2017 season | | | | | | | | | | | | | |
| Fodder crops | A1 | 226.10 | 2.15 | 134.71 | 19.79 | 14.44 | 4.74 | 43.55 | 217.86 | 177.56 | 30.45 | 1.22 | 22.52 |
| | A2 | 220.87 | 2.06 | 132.77 | 19.89 | 14.48 | 4.72 | 43.04 | 211.20 | 172.80 | 29.67 | 1.21 | 23.05 |
| | A3 | 232.60 | 2.11 | 136.93 | 19.40 | 14.75 | 4.79 | 43.54 | 224.62 | 187.76 | 30.93 | 1.91 | 25.68 |
| L.S.D 5% | | Ns | Ns | Ns | Ns | Ns | Ns | Ns | Ns | 9.49 | Ns | Ns | Ns |
| Rate fertilizer | B1 | 207.72 | 2.02 | 128.33 | 19.26 | 13.87 | 4.38 | 42.36 | 219.68 | 170.84 | 29.33 | 1.14 | 20.74 |
| | B2 | 226.56 | 2.06 | 135.69 | 19.53 | 14.36 | 4.68 | 43.32 | 203.1 | 174.49 | 29.33 | 1.19 | 24.12 |
| | B3 | 239.33 | 2.19 | 137.56 | 20.44 | 15.29 | 5.15 | 45.29 | 233.17 | 195.38 | 32.44 | 1,27 | 26.38 |
| | B4 | 231.78 | 2.14 | 137.44 | 19.62 | 14.73 | 4.82 | 43.21 | 219.01 | 186.31 | 30.89 | 1.22 | 23.69 |
| | B5 | 227.22 | 2.06 | 135 | 19.58 | 14.53 | 4.73 | 42.71 | 214.52 | 196.85 | 29.78 | 1.21 | 23.83 |
| L.S.D 5% | | 14.93 | Ns | Ns | Ns | 0.84 | 0.12 | Ns | Ns | Ns | Ns | Ns | 3.18 |
| Soild grain yield: 23.40 ardab fed$^{-1}$ | | | | | | | | | | | | | |
| 2018 season | | | | | | | | | | | | | |
| Fodder crops | A1 | 249.53 | 1.89 | 149.80 | 21.86 | 14.64 | 4.76 | 45.01 | 271.87 | 216.48 | 27.47 | 1.04 | 28.45 |
| | A2 | 252.73 | 1.81 | 148.73 | 21.57 | 14.64 | 4.75 | 44.42 | 262.22 | 216.53 | 31.13 | 0.992 | 29.41 |
| | A3 | 251.40 | 1.95 | 148.70 | 22.10 | 14.87 | 4.88 | 45.89 | 274.71 | 230.05 | 29.87 | 0.946 | 30.49 |
| L.S.D 5% | | Ns | 0.055 | Ns | Ns | Ns | 0.063 | Ns | Ns | Ns | Ns | Ns | Ns |
| Rate fertilizer | B1 | 247.44 | 1.82 | 142.78 | 20.72 | 14.29 | 4.47 | 42.89 | 243.45 | 205.85 | 27.67 | 0.954 | 28.15 |
| | B2 | 247.78 | 1.87 | 148.72 | 21.89 | 14.7 | 4.75 | 44.96 | 272.74 | 227.22 | 29.44 | 0.954 | 28.37 |
| | B3 | 256.67 | 1.93 | 153 | 22.84 | 15.26 | 5.17 | 46.96 | 287.73 | 228.74 | 32.22 | 1.073 | 31.5 |
| | B4 | 252.67 | 1.92 | 151.78 | 21.76 | 14.74 | 4.82 | 45.57 | 277.78 | 229.01 | 28 | 0.99 | 29.94 |
| | B5 | 251.57 | 1.88 | 149.11 | 22 | 14.59 | 4.78 | 45.15 | 266.67 | 214.89 | 30.11 | 0.984 | 29.33 |
| L.S.D 5% | | 8.37 | Ns | 8.79 | 1.21 | Ns | 0.088 | 1.996 | 21.47 | Ns | Ns | Ns | 2.18 |
| Soild grain yield: 24.00 ardab fed$^{-1}$ | | | | | | | | | | | | | |

**A1: Intercropping guar on maize**
**A2: Intercropping cowpea on maize**
**A3: Intercropping clitora on maize**
**B1: 100% mineral fertilization NPK of maize**
**B2: 100% Nanotechnology fertilization NPK of maize**
**B3: 75% Nanotechnology fertilization NPK + 25% mineral fertilization NPK of maize**
**B4: 50% Nanotechnology fertilization NPK + 50% mineral fertilization NPK of maize**
**B5: 25% Nanotechnology fertilization NPK + 75% mineral fertilization NPK of maize**

**Table 3. Combined of the two seasons, yield traits of intercropped maize with guar, cowpea , and clitora as affected by different rates of NPK mineral and NPK nano fertilizer.**

| Interc. Pattern (A ) | Rate Fertil. (B) | Plant height (cm) | Stem dimet. (cm) | Ear Height (cm) | Ear Length (cm) | Ear Rows (N0) | Ear dimater (cm) | No of Grain row | Weight Ear (g) | Grain yield /plant (g) | 100 weight Grain (g) | No. of ears /plant | Grain yield Ardab fed$^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fodder crops | A1 | 237.81 | 2.02 | 142.26 | 20.88 | 14.54 | 4.75 | 44.28 | 244.86 | 197.20 | 28.97 | 1.13 | 25.49 |
| | A2 | 236.80 | 1.94 | 140.75 | 20.68 | 14.70 | 4.74 | 43.73 | 236.71 | 194.67 | 30.40 | 1.100 | 26.23 |
| | A3 | 242.00 | 2.03 | 142.82 | 20.75 | 14.67 | 4.83 | 44.71 | 249.67 | 208.90 | 30.40 | 1.07 | 28.08 |
| L.S.D 5% | | Ns | 0.060 | Ns | Ns | Ns | 0.041 | Ns | 8.74 | 11.03 | Ns | Ns | Ns |
| Rate fertilizer | B1 | 227.58 | 1.92 | 135.56 | 19.99 | 14.08 | 4.42 | 42.63 | 231.57 | 188.35 | 28.5 | 1.047 | 24.45 |
| | B2 | 237.17 | 1.97 | 142.21 | 20.71 | 14.53 | 4.72 | 44.14 | 237.92 | 200.86 | 29.39 | 1.072 | 26.25 |
| | B3 | 248 | 2.06 | 145.28 | 21.64 | 15.28 | 5.16 | 46.13 | 260.45 | 212.06 | 32.33 | 1.172 | 28.94 |
| | B4 | 242.23 | 2.03 | 144.61 | 20.69 | 14.74 | 4.82 | 44.39 | 248.40 | 207.66 | 29.45 | 1.105 | 26.03 |
| | B5 | 239.40 | 1.99 | 142.06 | 20.79 | 14.56 | 4.76 | 43.93 | 240.60 | 205.87 | 29.95 | 1.097 | 25.99 |
| L.S.D 5% | | 6.45 | 0.091 | Ns | 0.822 | 0.562 | 0.0572 | 1.49 | 13.47 | 17.25 | Ns | Ns | 1.51 |

Solid grain yield: 23.70 ardab fed$^{-1}$

Solid guar yield: 15.47 ton fed$^{-1}$

Solid cowpea yield: 19,48 ton fed$^{-1}$

Solid clitiora yield: 10.85 ton fed$^{-1}$

**A1: Intercropping guar on maize A2: Intercropping cowpea on maize A3: Intercropping clitora on maize**
**B1: 100% mineral fertilization NPK of maize B2: 100% Nanotechnology fertilization NPK of maize**
**B3: 75% Nanotechnology fertilization NPK + 25% mineral fertilization NPK of maize**
**B4: 50% Nanotechnology fertilization NPK + 50% mineral fertilization NPK of maize**
**B5: 25% Nanotechnology fertilization NPK + 75% mineral fertilization NPK of maize**

The previous results indicate that yield components at grain yield / fed. of maize were higher when used clitoria as a companion crop. Compared to intercropping cowpea and guar. These results may be due to cowpea , guar are a fast starting crops, and have strong taproot that can complete effectively with maize for available moisture at all soil depth that led to higher competition with maize than clitoria. In addition to fodder crops legume have one cut during their life that led to much consumption the nutrient elements from the soil and then more effective on maize plants than maize soil. In consideration, fodder crops legume has positive effect on soil fertility and physiological properties, there significant amount of residual nitrogen for maize plants encourage maize plants and their maize growth characteristics than sole plants maize. These results are accordance with those obtained by (Ali and Atif 2011, Hediat and salama 2012, Sharif *et. al.*, 2014, Rameshaiah *et al.*, 2015 and Awad 2019 ).

**B- Effect of NPK mineral and nano particles fertilizer rates on maize:**

Data presented in Table 2&3 revealed the effect of spraying on soil application of NPK nano- compounds and mineral fertilizer on maize and companion crops. Plant height, stem and ear diameter are an important vegetative growth parameter of maize plant that are directly influenced by nano fertilizer. The data over seasons (Table3) revealed no significant differences among the different applications of nano and mineral fertilizer for ear height, 100 grain(g), grain/plant % characteristics. While, significant differences were found among the different applications for the other characters. Plant height, stem diameter, ear length, number of rows, ear diameter, number of grain rows, ear weight, grain / plant and grain yield recorded the highest significant values under the application of 75% nano fertilizer NPK+ 25% mineral fertilization of maize. The lowest values for the studied characters were recorded when the application of 100 % mineral fertilization NPK of maize. Suppan 2017 and Meena et al., 2017reported that, nano fertilizer enhance the yield components such as plant height, stem diameter, ear diameter etc., through, increasing the meristimatic activity and stimulation of cell elongation in plants. The increase in plant height in corn might be due to fundamental role of NPK in maintaining structural stability of cell membranes and use in protein synthesis, membrane function and cell elongation. It is because of that when materials are transformed to a nano scale, they change their physical, chemical and biological characteristics as well as catalytic properties and even more increase the chemical and biological activities. There were consistent and remarkable increases in ear characters when nano applications were used compared to mineral treatment.

Maize grain yield behaved in parallel way with yield components in the two seasons and combined (Table2&3) .Higher weight of 100 grain (32.33 g),ear weight ear (260.45 g), grain yield /plant (212.06 g), ears / plant (1.17) and grain yield (28.94 ardab/ fed$^{-1}$ ) were obtained by using 75% of NPK nano fertilizer + 25% of NKP mineral fertilizer as average over two seasons. Lower weight of 100 grain (28.50 g), weight ear (231.57g), grain yield /plant (188.35g), no of ear / plant (1.05) and yield (24.45 ardab/ fed-1 ) were obtained by using 100 % of NKP mineral fertilizer as average of the two seasons. It could be noted from the combined analysis (Table 3) that the yield of grain (ardab/fed) was representing 3.07, 9.71.18.11.8.95 and 8.81% of pure stand of maize NPK mineral and nano particles, respectively. (Hatwar *et al.*, 2003) revealed increased in chlorophyll content in wheat plants could be due to promotion of the absorption and utilization of nutrients such as nitrogen by nano-fertilizers compound. And that led to increased photosynthetic and other metabolic activity leading to an increase in various plant metabolites responsible for cell division and elongation

**C- Chemical analysis:**

Regarding the evaluation Maize quality under the intercropping pattern conditions, data in Table (4) reveled that intercropping fodder crops legume with maize had significant effect on all character under study in the two seasons and combined.

**Table 4. Effect of intercropped maize with guar ,cowpea , and cilitora as affected by NPK mineral and NPK nano fertilizer rate on protein % , phosphor% and potassium% of maize 2017 , 2018 and combined .**

| Intercropping. Intercropping Pattern (A ) | Rates of fertilizer | Nitrogen % | Protein % | Phosphor % | Potassium % |
|---|---|---|---|---|---|
| | | 2017 season | | | |
| Fodder Crops | A1 | 1.71 | 10.67 | 0.200 | 1.917 |
| | A2 | 1.83 | 11.42 | 0.223 | 2.153 |
| | A3 | 1.66 | 10.36 | 0.220 | 1.92 |
| L.S.D 5% | | 0.11 | 0.66 | 0.0017 | 0.0096 |
| Rates of fertilizer | B1 | 1.57 | 9.79 | 0.122 | 1.398 |
| | B2 | 1.83 | 11.47 | 0.177 | 1.777 |
| | B3 | 2.01 | 12.57 | 0.334 | 2.680 |
| | B4 | 1.70 | 10.61 | 0.261 | 2.286 |
| | B5 | 1.54 | 9.66 | 0.176 | 1.851 |
| L.S.D 5% | | 0.104 | 0.65 | 0.0010 | 0.0094 |
| Soil Maize | | 1.99 | 12.44 | 0.150 | 2.70 |
| | | 2018 season | | | |
| Fodder Crops | A1 | 1.77 | 11.05 | 0.204 | 1.992 |
| | A2 | 1.97 | 12.34 | 0.399 | 2.233 |
| | A3 | 1.73 | 10.85 | 0.235 | 2.098 |
| L.S.D 5% | | 0.19 | 1.17 | N.s | 0.0291 |
| Rates of fertilizer | B1 | 1.66 | 10.39 | 0.128 | 1.444 |
| | B2 | 1.90 | 11.85 | 0.275 | 1.859 |
| | B3 | 2.08 | 13.02 | 0.375 | 2.842 |
| | B4 | 1.811 | 11.32 | 0.340 | 2.379 |
| | B5 | 1.67 | 10.47 | 0.277 | 1.931 |
| L.S.D 5% | | 0.10 | 0.63 | N.s | 0.0368 |
| Soil Maize | | 2.02 | 12.63 | 0.170 | 2.78 |
| | | Combined | | | |
| Fodder Crops | A1 | 1.74 | 10.86 | 0.202 | 1.955 |
| | A2 | 1.90 | 11.88 | 0.311 | 2.193 |
| | A3 | 1.70 | 10.61 | 0.227 | 1.986 |
| L.S.D 5% | | 0.09 | 0.56 | N.s | 0.0153 |
| Rates of fertilizer | B1 | 1.61 | 10.06 | 0.125 | 1.421 |
| | B2 | 1.87 | 11.66 | 0.226 | 1.818 |
| | B3 | 2.05 | 12.79 | 0.337 | 2.761 |
| | B4 | 1.75 | 10.97 | 0.269 | 2.332 |
| | B5 | 1.61 | 10.09 | 0.276 | 1.891 |
| L.S.D 5% | | 0.07 | 0.44 | 0.0467 | 0.0190 |
| Soil Maize | | 2.01 | 12.54 | 0.160 | 2.74 |

**A1: Intercropping guar on maize**
**A2: Intercropping cowpea on maize**
**A3: Intercropping clitora on maize**
**B1: 100% mineral fertilization NPK of maize**
**B2: 100% Nanotechnology fertilization NPK of maize**
**B3: 75% Nanotechnology fertilization NPK + 25% mineral fertilization NPK of maize**
**B4: 50% Nanotechnology fertilization NPK + 50% mineral fertilization NPK of maize**
**B5: 25% Nanotechnology fertilization NPK + 75% mineral fertilization NPK of maize**

The maximum percentage of nitrogen, protein, phosphorus and potassium with intercropping cowpea with maize compared intercropping guar and clitiora in the two seasons and combined .The maize seed with intercropping cowpea protein % between from (11.42 &12.34%) in the two seasons. Mehdi *et. al.,(*2009) reported that the highest crude protein content was obtained by harvest time in milky stage (15.2%). It is suggested that maize–cowpea intercrops may have considerable potential as a high quality.

The highest values of the protein, phosphorus and potassium percentage (12.79, 0.337 and 2.761 %) respectively in the combined were obtained with using 75% Nano particles fertilization NPK + 25% mineral fertilization NPK fed-1 of maize. And the lowest values recorded ( 10.06 , 0.125 and1.421 % ) respectively , at 100% mineral fertilizer NPK . Thomison *et. al.,* (2004) reported that split applications of N increased grain protein concentration but had little or no effect on yield. Mongi *et. al.,* 1980 and Carpici *et. al.,*2010 reported that both the interactive and main effects of fertilizer and intercropping on crude protein content of maize and legume mixed forage was significant. The highest crude protein content of 12.98% was recorded for the crop fertilized with 150-100 kg NPK $ha^{-1}$ and intercropped with cowpea. Rozhin *et. al.,*( 2016) nano forms increased the phosphorus, crude protein, and soluble carbohydrate concentration compared to chemical forms.

**D-Interaction effect:**

All interactions between intercropping legume crops and rate NPK mineral and nano particles fertilizer did not show significant effect for all studied traits in first and second seasons in addition to the combined.

**2- Legume fodder crops.**

**A-Effect of intercropping legume fodder crops with maize:**

There were significant reduction to intercropping system of guar, cowpea and clitiora with maize on all growth traits; plant height, fresh yield / plant (g), dry yield / plant (g) , fresh yield /fed (ton) and dry yield/ fed (ton). (Table 5&6 ).

With regard to total fresh and dry yield / fed, intercropping pattern significantly decreased green forage yield / fed., in both seasons and combined Table 5&6.The fresh yield as compared to sole crop were 71.88, 65.09 and 88.20 % ton /fed., respectively in the combined. The best forage yield in the three fodder crops was cowpea fodder, which gave the highest yield compared to the guar and clitiora 7.27 & 6.37 ton .$fed^{-1}$ , in the 1st and 2nd seasons respectively . This is due to the fact that the growth of maize plants led to weak growth of intercropped forage crops which led to cutting once and the solo was cutting twice until the harvest of maize. These results are in agreement with those obtained by Pitan *et. al.*, 2001, Toaima 2006 , Ali and Atif 2011, Ahmed *et al.*, 2015 and Awad 2019).

**B- Effect of NPK mineral and nano particles fertilizer rates on legume forge crops:**

Results revealed that yield and component of guar, cowpea and clitiora were significantly affected by spraying on soil application of NPK nano- compounds and mineral fertilizer on maize and companion crops. Plant height, fresh yield / plant (g), dry yield / plant (g) , fresh yield /fed (ton) and dry yield/ fed (ton) .

Concerning to total fresh and dry yield /fed., intercropping pattern significantly decreased green forge yield / fed., in both seasons and combined (Table 4&5), the results show that the highest values were obtained when rate, NPK 100 % mineral and NPK 100% nano fertilizer (4.18 & 4.18 ton/fed.) in the average of seasons. The highest values of the total dry yield/ fed (1.59 ton/fed.) in the combined were obtained with using 75% Nano particles fertilization NPK + 25% mineral fertilization NPK fed-1 of maize. Due to the short duration of forage crops intercropping with corn, the effect of nano fertilizers on legume crop was not effective. These obtained results are in accordance with those obtained by ( Myaka 1995 , Anil *et al*., 1998, Carpici *et al.*, 2010, Ahmed *et al.*, 2015, and Rameshaoah *et al.*, 2015).

**C- Interaction effect:**

All interactions between intercropping legume crops and rate NPK mineral and nano particles fertilizer show did not significant effect for all studied traits in first and second seasons in addition to the combined

**Table 5. Yield traits of intercropped maize with guar, cowpea and cilitora as affected by different rates of NPK mineral and NPK nano fertilizer in 2017 and 2018 cropping seasons .**

| Intercropping Pattern (A) | Nano Fertilizer (B) | Plant Height (cm) | Fresh Weight / Plant (g) | Dry Weight / Plant (g) | Total fresh Yield / fed (ton) | Total dry Yield / fed (ton) |
|---|---|---|---|---|---|---|
| 2017 season | | | | | | |
| Fodder Crops | Guar | 119.92 | 78.47 | 15.25 | 4.81 | 0.75 |
| | Cowpea | 120.99 | 82.16 | 24.45 | 7.25 | 1.78 |
| | Clitiora | 83.67 | 18.70 | 7.59 | 1.23 | 0.94 |
| L.S.D 5% | | 16.70 | 12.50 | 2.14 | 0.94 | 0.46 |
| Nano fertilizer | B1 | 90.95 | 44.66 | 11.41 | 4.40 | 1.30 |
| | B2 | 104.22 | 52.70 | 15.69 | 4.10 | 1.25 |
| | B3 | 122.71 | 73.13 | 22.61 | 4.81 | 1.41 |
| | B4 | 116.03 | 67.05 | 17.01 | 4.46 | 1.01 |
| | B5 | 107.07 | 61.34 | 12.09 | 4.38 | 0.82 |
| L.S.D 5% | | 16.18 | 20.23 | 10.49 | 0.55 | N.s |
| 2018 season | | | | | | |
| Fodder Crops | Guar | 121.87 | 79.61 | 17.15 | 3.89 | 0.96 |
| | Cowpea | 125.47 | 90.14 | 19.87 | 6.37 | 1.45 |
| | Clitiora | 85.47 | 12.94 | 10.39 | 1.33 | 1.72 |
| L.S.D 5% | | 17.77 | 3.92 | 1.42 | 0.89 | 0.18 |
| Nano fertilizer | B1 | 97.00 | 41.65 | 10.44 | 3.62 | 1.20 |
| | B2 | 108.56 | 54.04 | 13.97 | 3.54 | 1.45 |
| | B3 | 122.22 | 73.80 | 20.16 | 4.27 | 1.77 |
| | B4 | 116.56 | 68.12 | 17.75 | 3.93 | 1.34 |
| | B5 | 110.11 | 66.85 | 16.70 | 3.62 | 1.12 |
| L.S.D 5% | | 16.86 | 11.35 | 4.34 | N.s | 0.52 |

**Table 6. Combined of the two seasons, yield traits of intercropped maize with guar ,cowpea and cilitora as affected by different rates of NPK mineral and NPK nano fertilizer.**

| Intercropping Pattern (A) | Rate Fertilizer (B) | Plant height (cm) | Fresh Weight /Plant (g) | Dry Weight /Plant (g) | Total fresh Yield / fed (ton) | Total dry yield / fed (ton) |
|---|---|---|---|---|---|---|
| Fodder crops | Guar | 120.89 | 79.04 | 16.20 | 4.35 | 0.85 |
| | Cowpea | 123.23 | 86.15 | 22.16 | 6.80 | 1.62 |
| | Clitiora | 84.57 | 15.81 | 8.99 | 1.82 | 0.33 |
| L.S.D 5% | | 10.14 | 5.45 | 1.07 | 0.51 | 0.21 |
| Rate fertilizer | B1 | 94.09 | 43.15 | 10.92 | 4.18 | 1.25 |
| | B2 | 106.39 | 53.37 | 14.83 | 4.18 | 1.35 |
| | B3 | 122.47 | 73.47 | 21.39 | 4.16 | 1.59 |
| | B4 | 116.29 | 67.59 | 17.38 | 4.04 | 1.18 |
| | B5 | 108.59 | 64.10 | 14.40 | 4.17 | 0.97 |
| L.S.D 5% | | 9.12 | 9.09 | 4.43 | N.s | 0.32 |
| Solid guar ton/ fed$^{-1}$ | | 114.00 | 81.25 | 21.80 | 15.47 | 3.78 |
| Solid cowpea ton/ fed$^{-1}$ | | 121.83 | 90.87 | 25.63 | 19.48 | 4.80 |
| Solid clitiorar ton/ fed$^{-1}$ | | 83.67 | 17.60 | 10.78 | 10.85 | 1.99 |

**C- Competitive relationships:-**

- **land equivalent ratio (LER)**

Result in Table (7) indicate that intercropping maize with guar, cowpea and clitiora as average of the two seasons . The values of land equivalent ratio for intercropping treatments were significantly greater than monoculture. It was the same (1.0) for all pure stands of main crop and intercrops. Intercropping cowpea with maize (B3) and using 75% nano fertilizer +25% mineral fertilizers recorded the highest values for (LER) which was 1.54. Intercropping clitiora with maize (B1) with using 100 % mineral fertilizer recorded the lowest values for (LER) which was 1.23.Similar results were obtained by Myaka, 1995, Ocaya *et al.,* 2001 , Toaima *et al.,* 2004 and Toaima 2006. Who found that LER values were greater with intercropping system than sole crop of them.

- **Area time equivalent ratio (ATER):**

High area time equivalent ratio (1.39) was obtained when intercropping cowpea with maize and using 75 % nano fertilizer +25% mineral fertilizer as average of two seasons. These values indicated that the intercropping system was highly efficient in utilizing the growth resources than sole cropping of both crops, (Table 7). Whereas, intercropping clitiora with maize and using 100 % mineral fertilizer recorded the lowest values of ATER (1.17) was obtained as an average of the two successive seasons. Similar results of high LER and ATER were reported by Verma *et al.,* 2005 and Wafaa *et al.,* 2013.

- **Effect of various cropping systems on Aggressivity (Agg)**

Data in Tables (7) show that aggressivity values of maize were positive, whereas values of all intercrops were negative, meaning that maize was dominant and the three intercrops were dominated. Similir results were recorded by Pitan *et al.,* 2001 and Toaima 2006.

- **Effect of various cropping systems on competitive ratio (CR)**

Data presented in Tables (7) revealed that the lowest values of CR where recorded maize intercropping of cowpea. However, the highest value of CR where recorded maize intercropping with cilitiora. The lower value of competitive ratio (CR) than cowpea intercropping with maize and using 100% mineral fertilizer NPK , but maize had higher value of CR than cilitiora intercropping with maize and using 25% nano + 75% mineral fertilizer NPK .. Similir results were recorded by Pitan *et al.,* 2001,Verma *et. al.,* 2005 and Wafaa *et al.,* 2013.

**-Total returns and monetary advantage index (MAI):**

The data of economic analysis as influenced by intercropping pattern and rate fertilization compared with solid planting of both crops are presented in Table (8). It reveals that the net return of using 75% non plus25 % mineral fertilizer for maize and cowpea intercrop recorded 8589.4L.E. $fed^{-1}$. While The monetary advantage index (MAI) recorded 4667.3 L.E. $fed^{-1}$ , meanwhile, the lowest net return was recorded for intercropping cilitiora with maize received rate of 100% mineral fertilizer 5432.2 L.E. $fed^{-1}$ and monetary advantage index (MAI) of 1253.59 L.E. $fed^{-1}$ an average of the two successive seasons.

**Table 7. Calculated data of competitive relationship and yield advantage for intercropping of guar, cowpea and cilitiora with maize and fertilizer rates of maize (combined of two seasons).**

| Intercropping patterns (A) | N+M fertilize | Land equivalent ratio LM + LB =L E R | | | ATER | Competitive ratio (CR) CR= CRM +CRB | | | Aggressivity (Agg) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LM | LB | LER | | CRM | CRB | CR | AM | AB |
| Guar (A1) | B1 | 1.06 | 0.33 | 1.39 | 1.24 | 1.56 | 0.64 | 2.20 | +0.60 | -0.60 |
| | B2 | 1.10 | 0.28 | 1.39 | 1.26 | 1.91 | 0.52 | 2.43 | +0.62 | -0.62 |
| | B3 | 1.14 | 0.30 | 1.44 | 1.31 | 1.85 | 0.54 | 2.39 | +0.64 | -0.64 |
| | B4 | 1.05 | 0.28 | 1.32 | 1.20 | 1.85 | 0.54 | 2.39 | +0.58 | -0.58 |
| | B5 | 1.03 | 0.29 | 1.32 | 1.19 | 1.76 | 0.57 | 2.32 | +0.57 | -0.57 |
| Mean | | 1.08 | 0.28 | 1.36 | 1.23 | 1.87 | 0.53 | 2.40 | +0.60 | -0.60 |
| Cowpea (A2) | B1 | 1.05 | 0.47 | 1.51 | 1.30 | 1.09 | 0.91 | 2.00 | +0.51 | -0.51 |
| | B2 | 1.13 | 0.35 | 1.48 | 1.32 | 1.56 | 0.64 | 2.20 | +0.57 | -0.57 |
| | B3 | 1.22 | 0.32 | 1.54 | 1.39 | 1.84 | 0.54 | 2.38 | +0.64 | -0.64 |
| | B4 | 1.09 | 0.34 | 1.44 | 1.28 | 1.57 | 0.63 | 2.20 | +0.57 | -0.57 |
| | B5 | 1.05 | 0.35 | 1.41 | 1.24 | 1.46 | 0.68 | 2.14 | +0.53 | -0.53 |
| Mean | | 1.11 | 0.35 | 1.46 | 1.30 | 1.55 | 0.64 | 2.19 | +0.56 | -0.56 |
| Cilitora (A3) | B1 | 1.11 | 0.12 | 1.23 | 1.17 | 4.45 | 0.22 | 4.67 | +0.57 | -0.57 |
| | B2 | 1.15 | 0.12 | 1.27 | 1.22 | 4.90 | 0.20 | 5.10 | +0.71 | -0.71 |
| | B3 | 1.31 | 0.14 | 1.44 | 1.38 | 4.72 | 0.21 | 4.93 | +0.81 | -0.81 |
| | B4 | 1.15 | 0.11 | 1.26 | 1.21 | 5.29 | 0.19 | 5.48 | +0.70 | -0.70 |
| | B5 | 1.21 | 0.11 | 1.32 | 1.27 | 5.40 | 0.18 | 5.58 | +0.75 | -0.75 |
| Mean | | 1.18 | 0.12 | 1.30 | 1.25 | 4.92 | 0.20 | 5.12 | +0.74 | -0.74 |

**A1: Intercropping guar on maize A2: Intercropping cowpea on maize A3: Intercropping clitora on maize**
**B1: 100% mineral fertilization NPK of maize B2: 100% Nanotechnology fertilization NPK of maize**
**B3: 75% Nanotechnology fertilization NPK + 25% mineral fertilization NPK of maize**
**B4: 50% Nanotechnology fertilization NPK + 50% mineral fertilization NPK of maize**
**B5: 25% Nanotechnology fertilization NPK + 75% mineral fertilization NPK of maize**

**Table 8. Economic analysis of intercropping pattern and rates of NPK nano and mineral fertilize of maize Combined season.**

| Intercropping patterns (A) | Rate Fertil. | Crop yield | | Total Income (LE /fed) | | Total income (LE /fed) | Total expenditure (LE /fed) | Net profit (LE /fed) | MAI |
|---|---|---|---|---|---|---|---|---|---|
| | | Maize ( Ardb /fed | Interc. Patte. (ton/fed) | Maize | Intercrop Pattern | | | | |
| A1 Guar | B1 | 25.05 | 3.97 | 13215 | 1191 | 13215 | 7535 | 5680 | 1593.67 |
| | B2 | 26.18 | 4.39 | 13883.4 | 1317 | 13883.4 | 7015 | 6868.4 | 2196.02 |
| | B3 | 27.05 | 4.67 | 14385 | 1401 | 14385 | 7145 | 7240 | 2507.97 |
| | B4 | 24.77 | 4.29 | 13176.6 | 1287 | 13176.6 | 7275 | 5901.6 | 1686.17 |
| | B5 | 24.39 | 4.44 | 13039.2 | 1332 | 13039.2 | 7405 | 5634.2 | 1609.77 |
| Mean | | 25.49 | 4.35 | 13540.2 | 1305 | 13540.2 | 7910 | 5630.2 | 1720.34 |
| A2 Cowpea | B1 | 24.78 | 7.26 | 14072.4 | 2178 | 14072.4 | 7535 | 6537.4 | 2476.93 |
| | B2 | 26.69 | 6.91 | 14884.2 | 2073 | 14884.2 | 7015 | 7869.2 | 3128.72 |
| | B3 | 28.83 | 6.32 | 15734.4 | 1896 | 15734.4 | 7145 | 8589.4 | 4667.3 |
| | B4 | 25.93 | 6.66 | 14444.4 | 1998 | 14444.4 | 7275 | 7169.4 | 2716.35 |
| | B5 | 24.93 | 6.89 | 14033.4 | 2067 | 14033.4 | 7405 | 6628.4 | 2459.60 |
| Mean | | 26.23 | 6.81 | 14633.4 | 2043 | 14633.4 | 7910 | 6723.4 | 2623.77 |
| A3 Clitiora | B1 | 26.19 | 1.32 | 12967.2 | 396 | 12967.2 | 7535 | 5432.2 | 1253.59 |
| | B2 | 27.31 | 1.25 | 13483.8 | 375 | 13483.8 | 7015 | 6468.8 | 1641.34 |
| | B3 | 30.93 | 1.47 | 15287.4 | 441 | 15287.4 | 7145 | 8142.4 | 2785.56 |
| | B4 | 27.34 | 1.16 | 13471.2 | 348 | 13471.2 | 7275 | 6196.2 | 1502.11 |
| | B5 | 28.65 | 1.19 | 14109 | 357 | 14109 | 7405 | 6704 | 1846.03 |
| Mean | | 28.08 | 1.28 | 13862.4 | 384 | 13862.4 | 7910 | 5952.4 | 1607.58 |
| Solid Maize | | | 23.7 | | | 11376 | 7535 | 3841 | |
| Solid Guar | | | 15.47 | | | 4641 | 5460 | -819 | |
| Solid Cowpea | | | 19.48 | | | 5844 | 5460 | 384 | |
| Solid Cilitiora | | | 10.85 | | | 3255 | 5460 | -2205 | |

**LE 480 for ardab of maize LE 300.0 for ton of guar, cowpea and cilitiora**

## CONCLUSION

Intercropping of legume crops with maize showed money benefits. Results indicated that maize- legumes intercrops produced greater seed yield than either crops grown alone. In addition, advantages were shown in land use efficiency expressed as greater LER than sole crops specially when non fertilizer of 75% nano NPK pluse 25% mineral fertilizer of maize .

Recommended was used for maize and cowpea intercrop. Moreover, the legume crops enhance land fertility through the natural nitrogen fixed by legume crop. More than less, using non fertilizing is a profitable component in agricultural practices as it has a rapid impact on plant. Utilization, reduce the amount of fertilization which almost has harmful side effect for human and animals. So that, the pattern of maize-cowpea intercrop fertilized with 75% nano fertilizer NPK plus 25% mineral fertilizer NPK of the recommended for maize were more profitable for farmer.

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## تحميل بعض محاصيل العلف البقولية مع الذرة الشامية تحت مستويات من الاسمدة المعدنيه واسمدة النانو تكنولوجى

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**قسم بحوث التثكيف المحصولى – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة – مصر**

نظرًا لنقص مساحة محاصيل الأعلاف الصيفية نتيجة المنافسة مع المحاصيل الرئيسية في التركيب المحصولى مثل الذرة الشاميه ، تم تحميل ثلاثة من محاصيل العلف البقوليه الصيفيه مع الذرة الشامية لزيادة أنتاج الأعلاف وأمداد التربة بالنيتروجين الطبيعى. علاوة على ذلك فان أستبدال الاسمدة المعدنيه باسمدة جديدة مثل أسمدة النانو تكنولوجى ستؤدى للحد من تلوث التربة وزيادة كفاءة نمو النبات مما ينعكس على زيادة محصول الذرة الشامية . لذلك تم إجراء تجربة في محطة ملوي للبحوث الزراعية ، بمحافظة المنيا ، مركز البحوث الزراعية ، خلال موسمين صيفيين متعاقبين ٢٠١٧ و ٢٠١٨ لدراسة تأثير زراعة المحاصيل الثلاثة من الأعلاف على الجودة والربحية للذرة الشامية صنف جيزة ١٦٨ (الذرة الصفراء) وباستخدام أسمدة النانو تكنولوجى و الأسمدة المعدنية (نيتروجين وفوسفور بوتاسيوم ) .أستخدم تصميم قطعة منشقة مرة واحدة فى أربع مكررات. تم تخصيص القطع الرئيسية لمحاصيل العلف الثلاثة التالية: الجوار ولوبيا العلف والكلايتوريا بنسبة ٥٠ ٪ من الموصى به. تم تخصيص المعدلات التالية من الأسمدة النانويه والأسمدة المعدنية الكلية بنسبة ( ١٠٠ ٪ من سماد النانو تكنولوجى – ١٠٠% من الاسمدة المعدنية الكلية – ٧٥ % من السماد النانو+ ٢٥ % من الاسمدة المعدنية الكلية – ٥٠ % من كل من السماد النانو والمعدنى- ٢٥ % من سماد النانو + ٧٥% من الاسمدة المعدنية الكلية من الموصى بة للذرة الشامية وتم ذلك فى القطعة المنشقة من التصميم الاحصائى . يمكن تلخيص النتائج التي تم الحصول عليها على النحو التالي :- كان لتحميل الجوارر ولوبيا العلف والكلايتوريا مع الذرة تأثير كبير على كل طول النبات بالسم وسمك الساق بالسم وسمك الكوز وعدد الصفوف فى الكوز وعدد الحبوب فى الصف ووزن الكوز بالجم ووزن حبوب الكوز ومحصول الفدان حبوب بالاردب وذلك فى متوسط الموسمين. أعطت الذرة الشامية المنفردة أفضل النتائج فى جميع معاملات التحميل. كانت نباتات الذرة الشامية المنفردة أقل من الذرة المحمل عليها محاصيل العلف الثلاثة وذلك فى متوسط الموسمين حيث وجد أن نسبة الزيادة فى محصول الذرة المحمل أعلى من المنفرد بنسبة ٧.٥٥و١٠.٦٨ و ١٨.٤٨ ٪ مع الجوار ولوبيا العلف والكلايتوريا على التوالى. كان تأثير الرش الارضى من سماد النانو والاسمدة المعدنية تأثير كبيرا على المحصول ومكوناتة من الذرة الشامية. وذلك يرجع الى ان سماد النانو كان لة تاثير على مكونات المحصول وكانت كل صفات المحصول فى زيادة عند استخدام ٧٥%سماد النانو+٢٥%من الاسمدة المعدنية الكلية . كانت الزيادة فى محصول الذرة الشامية عند أستخدام هذة المعدلات من الاسمدة أعلى من المنفرد بنسبة ٣.٧و٩.٧١و١٨.١١و٨.٩٥و ٨.٨١ % مقارنة بالمنفرد فى متوسط الموسمين. بزيادة نسبة سماد النانو زاد ت النسبة المئويه لكل من البروتين والفوسفور والبوتاسيوم فى حبوب الذرة الشامى بالمقارنة بالمنفرد وذلك فى كلا الموسمين وكذلك متوسط الموسمين. سجل تحميل لوبيا العلف مع الذرة مع أستخدام ٧٥% من سماد النانو أعطى أعلى معدل من أستغلال الارض والمكافئ الزمنى لاستغلال الارض وكانت كالتالى ١.٥٤و ١.٣٩ وذلك فى متوسط الموسمين .وتحميل الكلايتوريا مع أستخدام ١٠٠% من السمادالمعدنى أعطى أقل معدل لاستغلال الارض والمكافئ الزمنى للارض . كان صافى الربح للمزارع أعلى عند تحميل لوبيا العلف عاى الذرة الشامية والتسميد بمعدل ٧٥% من سماد النانو حيث أعطى الفدان ربحية ٨٥٨٩.٤ جنيها مصرى وميزة محصولية ٤٦٦٧.٣ جنيها مصرى. وأقل ربحيه وميزة محصولية عند تحميل الكلايتوريا والتسميد بنسبة ١٠٠ % من السماد االمعدنى و كانت ٥٤٣٢.٢ جنيها و الميزة المحصولية ١٢٥٣.٥٩ جنيها مصرى فى متوسط الموسمين. توصى الدراسة بتحميل لوبيا العلف على الذرة الشاميه بنسبة ٥٠% من الموصى بة لتوفير الاعلاف الخضراء فى فصل الصيف والتسميد بمعدل ٧٥% من سماد النانو +٢٥%من الاسمدة المعدنية الكلية للحصول على أعلى محصول من الذرة الشامية وأعلى ربحية للمزارع وذلك تحت ظروف مصر الوسطى.