# Interspecific Competition on Peanut (*Arachis Hypogaea* L.) Population as Intercropping and Weed Control on Corn (*Zea Mays* L.)

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**Abstract:** *The experiment conducted to study interspecific competition of corn and peanut as intercropping in intercropping system. The research conducted from April 2013 to July 2013. The experimental design of the research was Split Plots Design (SPD). Numbers of row for the peanut as the main plot (MP) by 3 levels and weed control method as the as the son plot (SP) by 4 levels and as well as monoculture of corn and peanut. Results of the research showed that intercropping system using corn and peanut has not given significant influence on all components yields of corn. Meanwhile, peanut has significant influence on yields of peanut. Result of the analysis on interspecific competition between corn and peanut showed that corn was more dominant and competitive.*

**Keywords:** Corn, peanut, intercropping, competition

## 1. Introduction

Corn (*Zea mays* L.) is commodity that having high economic value and prospective to be developed in Indonesia. The demand of corn in 2010 was 19.86 million tons of grains and in 2011 was 19.93 million tons [1]. The demand of corn keeps increasing along with awareness on the importance of public nutrition fulfillment, the growth rate of population, development of industry and the need for feedstuff, but both productivity and land property of the farmer have kept reducing. In order to improve land productivity, some efforts have been done such as arranging the corn's planting pattern by double row under intercropping system. The planting pattern arrangement by double row is done by giving wider space following the double row. Such row spacing is intended to give more space for light interception to facilitate the photosynthetic process.

Intercropping is one of planting system in which more than two different types of crop are planted intermittently and under regulated space on the same field [2]. [3] revealed that intercropping has some advantages, such as improving efficient land use, stability of the crop production, and increasing income by the increasing harvest yield. Moreover, based on the ecological aspect, such intercropping system could inhibit the weed growth, reduce the pest and disease attacks, and improve soil fertility through N fixation in intercropping by legume crops [4].The intercropping pattern increases competition in struggling for the growth factors, such as nutrients, water, and sunrays. Competition is defined as competition among individual crop in a population to obtain the required resources, for example, sunrays, water, and nutrients. Competition may occur among individuals of intra-species and or inter-species.

Intra-species competition occurs due to space arrangement and number of crops per hole to gain optimal population in order to obtain maximum yields. Inter-species competition is competition between different types of crop in multiple-cropping system and competition between crops and weeds [5]. Competition in intercropping system is divided into three forms that include mutual-inhibition, mutual-cooperation, and compensation. Efforts to minimize the risk of inhibiting competition in intercropping include arranging density of the crop population. [5] stated that one of factors, which lead to competition, is density of the crop population. Competition may occur earlier if density of the crop population is getting higher. Under lower density of population, the competition may occur slower, but the crops will grow well. However, under lowest density of population, the competition may not occur till the end of the crop growth. Both growth and yield of harvest per crop may high, but the yield per area unit is low due to less number of crops.

## 2. Materials and Methods

The research conducted at TEU (Technical Executive Unit) of the Seed Crops Development in Randuagung Village of Singosari Subdistrict. The research conducted from April 2013 to July 2013. The experimental design of the research was Split Plots Design (SPD). Numbers of row for the peanut as the main plot (MP) by 3 levels and weed control method as the as the sub plot (SP) by 4 levels. The experiment will be repeated for 3 replications. Numbers of row for the peanut (MP) that comprise of 3 levels, such as: $J_1$ :Two rows of peanut (40 x 25 cm), $J_2$ : Three rows of peanut (30 x 25 cm), $J_3$ : Four rows of peanut (20 x 25 cm). Method of the weed control as sub plot (SP) that comprises of 4 levels, such as :$P_1$: Without weeding, $P_2$ : Once weeding (21 dap), $P_3$ : Twice weedings (21 dap and 42dap), $P_4$ : Three times weeding (21 dap, 42 dap and 63 dap) as well as monoculture of corn and peanut.

The observation includes observation on the crops of corn and peanut. Observation on the harvest of corn includes the grain weight, 100 seeds weight and yields per hectare. Observation on the harvest of peanut includes the seeds weight per crop, 100 seeds weight, and the yield per hectare. The obtainable data will be analyzed using analysis of variance (F-test in 5% level) in order to find out effect of the given treatment. If any effect of the treatment occurs, it will be followed by a comparison test between treatments, such

as the Smallest Significance Difference (SSD) test in 5% level. A Contrast Orthogonal test is applied to find out the influence of intercropping in comparison with monoculture.

Land Equivalent Ratio (LER) defined as how to evaluate efficient land use. According to [6], the equation is given as follows:

$$LER = Lx + Ly = \frac{Ax}{Px} + \frac{Ay}{Py}$$

In which: Ax = the yield of crop x under intercropping pattern, Px = the yield of crop x under monoculture pattern, Ay = the yield of crop y under intercropping pattern, Py = the yield of crop y under monoculture pattern.

Aggressivity is defined to measure competition between species in intercropping by relating yields of both crops. According to [7], the equation is:

$$A = \frac{Yia}{Ysa \times Fa} - \frac{Yib}{Ysa \times Fb}$$

In which: A= Aggressivity; Yia, Yib = The Yields of intercropping a and b; Ysa, Ysc = Yield of monoculture a and b; Fa = Proportion of crop a in combination with crop b; Fb = Proportion of crop b in combination with crop a.

Relative Crowding Coefficient is used to evaluate and compare the competitive ability with other species in intercropping system. In accordance with [7], the equation is given below:

$$Ka = \frac{Yia \times Fb}{(Ysa - Yia) \times Fa}$$
$$Kb = \frac{Yib \times Fa}{(Ysb - Yib) \times Fb}$$

In which: Ka, Kb = Relative Crowding Coefficient a and b; Yia, Yib = Yields of intercropping a and b; Ysa, Ysc = Yields of monoculture a and b; Fa = Proportion of crop a in combination with crop b; Fb = Proportion of crop b in combination with crop a.

The competitive ratio is applied to evaluate competitive abilities of the different species in intercropping system. In accordance with [7], the equation is given below:

$$CRa = \frac{Yia / (Ysa \times Fa)}{Yib / (Ysb \times Fb)}$$
$$CRb = \frac{Yib / (Ysb \times Fb)}{Yia / (Ysa \times Fa)}$$

In which: CRa, CRb = Competitive Ratio of a and b; Yia, Yib= Yield of intercropping for a and b; Ysa, Ysc = Yield of monoculture for a and b; Fa = Proportion of crop a in combination with b; Fb = Proportion of crop b in combination with a.

## 3. Result and Discussion

### 3.1 Yield components of corn and peanut

Based on Table 1, it shows that the corn yield gives no difference toward seed weight per crop, 100 seeds and production per hectare under treatment for numbers of row and weed control. For results that give no difference among treatment mean that peanut as intercrop for diverse numbers of row have insignificant influence. It shows that corn is the most dominant component in intercropping in combination with peanut. Dominance of corn has won the competition of interspecies with peanut in obtaining the growth factor [8]. The corn's roots, which are grown in intercropping system,

occupy wider growing space over other crop. It shows that wider growing space of the roots could reduce any competition among crops and increase optimal nutrient absorption [9]. The harvest yields are affected by biomass production resulted during vegetative period, when total dry weight of the crops is resulted. As explained by [10] that one of the growth factors, which determine the yield, is biomass production besides the genetic factor and allocation level of photosynthate to the harvested parts (physiological traits). During the vegetative phase, the accumulated photosynthatein total dry weight will be translocated to develop ear formation of the corn.

Results of the peanut as presented in Table 2 show that comparison between monoculture and intercropping describes some differences toward the seed weight per crop, 100 seeds weight and production per hectare. Treatment for numbers of row on peanut shows differences over the seed weight per crop and production per hectare. Whereas, weed control treatment gives no difference toward 100 seeds weight, but shows some differences toward seed weight per crop and production per hectare.

In comparison between monoculture and intercropping, it shows significant influence on the seed weight per crop, 100 seeds weight and production per hectare. This is due to no competition in monoculture with the corn and no shade. High shade could reduce the pod formation and the seeds as result of the research by [11]. During high pod formation per crop by indifferent numbers of seeds causes high numbers of seeds per crop as well [12]. Based on Table 2, numbers of row treatment for peanut show significant influence on seed weight per crop and production per hectare. Based on Table 2, the seed weight per crop of treatment for numbers of row $J_1$ (2 rows) show insignificant difference with treatment $J_2$ (3 rows) but shows significant difference with treatment $J_3$ (4 rows). Meanwhile, for production per hectare, numbers of row treatment $J_1$ (2 rows) showsignificant difference with numbers of row $J_2$ (3 rows) and numbers of row $J_3$ (4 rows), treatment for numbers of row $J_2$ (3 rows) has also significant difference with numbers of row $J_3$ (4 rows). For weed control, it shows insignificant difference on seed weight per crop, 100 seeds weight and production per hectare. Lower numbers of filled pods cause reduced seed weight per crop. However, along with the increasing number of population per area unit of land, yield of peanuts in denser population result higher production in comparison with yields of peanut, which are grown in less dense population. [13] explained that the increasing population of crop could reduce the yield per individual crop, but it could improve the yield per area unit of land.

**Table 1:** Means of yield Seed of corn under treatment of numbers of row for peanut and weed control

| Treatment | Yield seed of corn | | |
|---|---|---|---|
| | Weight per crop (g) | Weight 100 seeds (g) | Production (ton ha$^{-1}$) |
| **Monoculture vs Intercropping** | | | |
| Monoculture | 196,90 | 37,63 | 10,73 |
| Intercropping | 196,22 | 36,26 | 10,52 |
| **Numbers of row for peanut** | | | |
| J$_1$ | 196,50 | 36,45 | 10,53 |
| J$_2$ | 196,46 | 35,49 | 10,53 |
| J$_3$ | 195,68 | 36,83 | 10,49 |
| SSD 5 % | insig | insig | insig |
| **Controlling weeds** | | | |
| P$_1$ | 196,46 | 36,26 | 10,53 |
| P$_2$ | 195,51 | 35,92 | 10,48 |
| P$_3$ | 196,23 | 36,09 | 10,52 |
| P$_4$ | 196,66 | 36,76 | 10,54 |
| SSD 5 % | insig | insig | insig |

Notes: insig = insignificant difference, dap = dap = days after planting.

**Tabel 2:** Means of yield Seed of peanut under treatment of numbers of row for peanut and weed control

| Treatment | Yield seed of peanut | | |
|---|---|---|---|
| | Weight per crop (g) | Weight per crop (g) | Weight per crop (g) |
| **Monoculture vs Intercropping** | | | |
| Monoculture | 7,27 B | 44,64 B | 1,47 B |
| Intercropping | 2,70 A | 35,53 A | 0,21 A |
| **Numbers of row for peanut** | | | |
| J$_1$ | 2,87 b | 37,06 | 0,15 a |
| J$_2$ | 2,80 b | 35,38 | 0,22 b |
| J$_3$ | 2,43 a | 34,15 | 0,26 c |
| SSD 5 % | 0,25 | insig | 0,02 |
| **Controlling weeds** | | | |
| P$_1$ | 2,41 | 33,77 | 0,18 |
| P$_2$ | 2,84 | 33,93 | 0,22 |
| P$_3$ | 2,85 | 35,84 | 0,22 |
| P$_4$ | 2,73 | 36,58 | 0,21 |
| SSD 5 % | insig | insig | insig |

Notes: Numbers followed by the same letter in the same column show insignificant difference. Capital letter by Contrast Orthogonal test and small letter based on test of SSD 5%; dap = days after planting; insig = insignificant difference.

## 3.2 Competition

Efficient land use in intercropping system can be seen from land equivalent ratio (LER) in Table 3. Result of calculation for land equivalent ratio on corn and peanut in intercropping system gives high yield under treatment of four rows of peanut by twice weeding (21 dap and 42 dap) (J$_2$P$_3$) for about 1.23. This value, 1.23, shows that in order to gain yield, which parallel to intercropping, it requires land area 1.23 times wider to grow monoculture of corn and peanut. If the value of LER > 1, it means profitable, LER < 1 means the intercropping is unprofitable, and LER = 1 means the yield of intercropping is equivalent to monoculture [10]. LER value shows whether the cropping and intercropping are efficient or not in comparison with monoculture. [14] stated that the highest LER will be obtained under denser

population, which is shown by higher yield of intercropping under denser population, but it does not mean better than optimal yield that might be gained.

**Table 3:** Land Equivalent Ratio (LER)

| Treatment | LER |
|---|---|
| J$_1$P$_1$ | 1,07 |
| J$_1$P$_2$ | 1,09 |
| J$_1$P$_3$ | 1,09 |
| J$_1$P$_4$ | 1,11 |
| J$_2$P$_1$ | 1,12 |
| J$_2$P$_2$ | 1,14 |
| J$_2$P$_3$ | 1,14 |
| J$_2$P$_4$ | 1,16 |
| J$_3$P$_1$ | 1,12 |
| J$_3$P$_2$ | 1,18 |
| J$_3$P$_3$ | 1,23 |
| J$_3$P$_4$ | 1,17 |

LER: Land Equivalent Ratio

Aggressivity is applied to measure competition among species in intercropping system. Results of the research show negative value of aggressivity in all treatments (Table 4). The value is negative due to corn is more dominant in comparison with peanut in intercropping system. Corn has higher competitive ability in comparison with peanut [7].

Relative Crowding Coefficient (Rcc) is applied to evaluate and compare the competitive ability with other species in intercropping system. The Relative Crowding Coefficient value on corn is higher in comparison with relative crowding coefficient value on peanut (Table 5). Relative Crowding Coefficient value on corn shows the value higher than 1 (> 1). Rcc value for corn is higher than 1, which means that the obtained yield has beyond the expected yield, but a stressing occurs on peanut (Rcc peanut < 1) in mixed cropping or corn is more dominant than peanut. This conforms to the research conducted by [15] and [16]. Closeness of species in mixed cropping system is important because it affects the competitive level intra-and-inter-species. Both competitions will be strict along with the increasing age of the crop.

Competitive Ratio (CR) to evaluate different competitive ability of the species in intercropping. Results of the research show that the competitive ratio value of corn is higher than peanut (Table 6). CR value is higher than 1 (CR > 1) shows that it has high competitive ability. Results of the research show that intercropping pattern between cornand peanut, it seems that corn is more competitive the peanut. Species that having strong competitive ability, is usually so-called as dominant species or superior competitor and has higher capacity to obtain resources and to occupy the existed ecology [17]. Productivity of the dominant species has directly affected the real performance of intercropping [9]. Therefore, interspecific of competitive behavior is important for structural stability of intercropping-agroecosystem. Furthermore, knowledge about competitive ability could predict the yield in intercropping system.

**Table 4:** Aggressivity value

| Treatment | A |
|---|---|
| $J_1P_1$ | -0,0069 |
| $J_1P_2$ | -0,0068 |
| $J_1P_3$ | -0,0069 |
| $J_1P_4$ | -0,0062 |
| $J_2P_1$ | -0,0064 |
| $J_2P_2$ | -0,0054 |
| $J_2P_3$ | -0,0050 |
| $J_2P_4$ | -0,0051 |
| $J_3P_1$ | -0,0055 |
| $J_3P_2$ | -0,0038 |
| $J_3P_3$ | -0,0028 |
| $J_3P_4$ | -0,0043 |

A : Aggressivity

**Table 5:** Relative Crowding CoefficientValue

| Treatment | Rccof corn | Rccof peanut |
|---|---|---|
| $J_1P_1$ | 14,15 | 0,31 |
| $J_1P_2$ | 18,25 | 0,34 |
| $J_1P_3$ | 22,41 | 0,33 |
| $J_1P_4$ | 21,88 | 0,42 |
| $J_2P_1$ | 52,57 | 0,40 |
| $J_2P_2$ | 14,07 | 0,52 |
| $J_2P_3$ | 12,48 | 0,56 |
| $J_2P_4$ | 25,75 | 0,57 |
| $J_3P_1$ | 13,46 | 0,49 |
| $J_3P_2$ | 12,97 | 0,75 |
| $J_3P_3$ | 21,88 | 0,94 |
| $J_3P_4$ | 14,74 | 0,68 |

Rcc: Relative Crowding Coefficient

**Tabel 6:** Competitive Ratio Value

| Treatment | CR of corn | CR of peanut |
|---|---|---|
| $J_1P_1$ | 3,45 | 0,29 |
| $J_1P_2$ | 3,25 | 0,31 |
| $J_1P_3$ | 3,33 | 0,30 |
| $J_1P_4$ | 2,69 | 0,37 |
| $J_2P_1$ | 2,83 | 0,35 |
| $J_2P_2$ | 2,23 | 0,45 |
| $J_2P_3$ | 2,08 | 0,48 |
| $J_2P_4$ | 2,09 | 0,48 |
| $J_3P_1$ | 2,32 | 0,43 |
| $J_3P_2$ | 1,64 | 0,61 |
| $J_3P_3$ | 1,40 | 0,72 |
| $J_3P_4$ | 1,77 | 0,56 |

CR : Competitive Ratio

## 4. Conclusion

Based on result of the research, some conclusions can be drawn that intercropping between corn and peanut as intercrop by regulating population of peanuts and controlling weeds show that corn is more dominant and competitive in intercropping system.

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