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The Effect of Habitat Modification on Plant-Pollinator Network Tien Aminatun1,a) and Nugroho Susetya Putra2) 1)Department of Biology, Faculty of Mathematics and Natural Science, Yogyakarta State University Jl Colombo No. 1, Karangmalang, Depok, Sleman, Yogyakarta, Indonesia 2)Faculty of Agriculture, Gadjah Mada University Bulaksumur, Depok, Sleman, Yogyakarta, Indonesia a)Corresponding author: tien_aminatun @uny.ac.id Abstract. The research aimed to determine; (1) the mutualism interaction pattern of plant-pollinator on several habitat modifications; and (2) the habitat modification which showed the most stable pattern of interaction.The study was conducted in one planting season with 20 plots which each plot had 2x2 m2 width and 2 m spacing among plots, and each plot was planted with the same variety of tomato plants, i.e. “intan”. Nitrogen manipulation treatment was conducted with four kinds of fertilizers, i.e. NPK (code PU), compost (code PKM), vermicompost (code PC), and manure (code PK). Each treatment had 5 plot replications. We observed the growth of tomato plants, weed and arthropod populationstwo weekly while pollinator visitation twice a week during tomato plant flowering with counting population and visitation frequence of each pollinator on each sample of tomato plants.The nectar of tomato plant flower of each treatment was tested in laboratory to see its reducing sugar and sucrose. Oganic matter and nitrogen of the soil samples of each treatment were tested in laboratory in the beginning and the end of this research. We analized the plant-pollinator network with bipartite program in R-statistics, and the abiotic and other biotic factors with descriptive analysis.The results of the research were; (1) the mutualism interaction pattern of plant-pollinator network of four treatments were varied, and (2) The pattern of plant-pollinator network of NPK fertilizer treatment showed the more stable interaction based on analysis of interaction evenness, Shannon diversity, frequency and longevity of pollinator visitation. INTRODUCTION Land conversion occurring in many natural ecosystems into agricultural ecosystems changes the composition and biodiversity, whereas habitat modification affects interaction among species. Tylianakis, et al. suggested that modification of agricultural habitat affected the host-parasitoid food-web structure[1]. The interaction among species and robustness of interaction network against species extinction is important to determine the extinction effect of species. There are various interaction networks in ecosystem, namely food-web, parasitoid web, seed dispersal network, and pollination network[2]. Habitat modification that causes habitat condition change may occur due to natural process as well as human activity. Hoover, et al. indicated that the interaction among heating effect of ambient temperature, variation of CO2 content in air, and soil nitrogen deposition had an effect on mutual interaction between plant and pollinator insect on pumpkin farming field. The effect on the interaction of mutualism occurs through the bottom-up mechanism, i.e. the interaction among temperature, nitrogen and CO2 will affect the morphology, phenology and nectar chemical content of the plant, and ultimately will affect the visitation, consumption and longevity of the pollinator visitation[3].Therefore, the research aimed to determine; (1) the mutualism interaction pattern of plant-pollinator on several habitat modifications; and (2) the habitat modification which showed the most stable pattern of interaction The 4th International Conference on Research, Implementation, and Education of Mathematics and Science (4th ICRIEMS) AIP Conf. Proc. 1868, 090004 -1– 090004 -11; doi: 10.1063/1. 4995196 Published by AIP Publishing. 978-0-7354-1548-5/$30.00 METHODS Preparation of the Experimental Design This research with complete randomized design was conducted directly on the agricultural ecosystem of tomato plants in the field of Research Garden owned by the Faculty of Agriculture ofGadjahMadaUniversity in Banguntapan ofBantul Regency. The independent variable of this research was soil nitrogen content as habitat modification factor, whereas the dependent variable was the pattern of mutual interaction between tomato plant and pollinator insect (plant-pollinator network), and the supporting variableswere population of all types of insects that interacted with tomato plants, reducing sugar and sucrose contents of tomato flower nectar, and the species of weed that most presented around the tomato cultivation. The research was conducted by making 20 plots which was 2x2 m2per plot and the distance among plotswas 2m. Each plot was planted with tomato plant with the same variety, with spacing of approximately 50 cm so that each plot contained 16 tomato plants. The treatment included nitrogen manipulation with application of various fertilizer, those were NPK fertilizer, vermicompost, compost, and manure. Each treatment had 5 replication plots. The plots with standard NPK fertilizer dosage treatment or commonly applied by tomato farmers in general were applied as control treatment. Each plot had certain code according to the combination of treatment, namely: a. Control = application of manure and chemical fertilizer (NPK) according to general tomato farmer (code: PU), with 5 replication plots (codes: PU1, PU2, PU3, PU4, PU5) b. Application of manure (code: PK), with 5 replication plots (codes: PK1, PK2, PK3, PK4, PK5) c. Application of vermicompost fertilizer (code: PC), with 5 replication plots (codes: PC1, PC2, PC3, PC4, PC5) d. Application of compost fertilizer (code: PKm), with 5 replication plots (PKm1, PKm2, PKm3, PKm4, PKm5) Measurements The research was conducted during one growing season. The observation was conducted every 2 weeks from the beginning of growing season until harvesting to see the growth and development of tomato plant, weed and arthropod population.The arthropods observed included the types of carnivores, herbivores, and scavengers (saprophages). The presence of arthropods on plant canopy was observed on the tomato plant and weed samples in sitely and periodically every two weeks in the beginning of planting until the harvest (5 times observation).The samples of tomato plants observed were three plants per plot and the weed samples observed were three weeds that grew most dominant in each plot.The frequency of presence was calculated for one growing season which was the sum of presence frequencies from each observation week. Observation of pollinator insect visitation was conducted twice a week during flowering of tomato plant by counting the population and presence frequency of each pollinator insect on each tomato plant sample (5 times observation).Nectar sample from tomato flower of each treatment was tested in the laboratory of Faculty of Agricultural Technology of Gadjah Mada University to find out the reducing sugar and sucrose contents. The contents of organic matter and soil nitrogen were tested in the laboratory of BPTP Maguwoharjo for each soil sample from each treatment at the beginning and the end of the study. Plant-pollinator network of each treatment plot was analyzed with bipartite in R-statistic programme, while the abiotic and biotic factors wereanalyzed with descriptive comparative. RESULTS AND DISCUSSION The Presence Frequency of Arthropod on the Plant Canopy and Its Interaction Pattern The presence frequency of arthropod on the plant canopy in the NPK fertilizer treatment is presented in Table 1. TABLE 1.Presence frequency of arthropod on plant canopy in the NPK fertilizer treatment (code PU) Visited plant Visiting arthropod Trophic status Presence frequency(times) Cyperus rotundus Coccinellidae Predator 4 Cyperus rotundus Libellulidae Predator 2 Solanum Lycopersicum Achilidae Herbivore 7 (tomato) Cyperus rotundus Acrididae Herbivore 7 Solanum Lycopersicum Libellulidae Predator 6 Solanum Lycopersicum Bemisia tabaci Herbivore 11 Solanum Lycopersicum Acrididae Herbivore 9 Cyperus rotundus Bemisia tabaci Herbivore 3 Solanum Lycopersicum Syrphidae Predator 1 Solanum Lycopersicum Spodoptera litura Herbivore 5 Solanum Lycopersicum Sogatella sp. Herbivore 8 Cyperus rotundus Achilidae Herbivore 2 Solanum Lycopersicum Aphididae Herbivore 55 Solanum Lycopersicum Recilia dorsalis Herbivore 1 Solanum Lycopersicum Ulidiidae Scavenger 2 Solanum Lycopersicum Helicoverpa sp. Herbivore 14 Solanum Lycopersicum Tetragnatha sp. Predator 1 Solanum Lycopersicum Formicidae Predator 6 Solanum Lycopersicum Salticidae Predator 3 Solanum Lycopersicum Lycosidae Predator 3 Solanum Lycopersicum Proutista moesta Herbivore 1 Solanum Lycopersicum Chironomidae Predator 4 Solanum Lycopersicum Nephotettix sp. Herbivore 3 Solanum Lycopersicum Curculionidae Predator 1 Solanum Lycopersicum Plusia sp. Herbivore 1 Solanum Lycopersicum Xylocopa virginica Pollinator 9 Solanum Lycopersicum Drosophila sp. Pollinator 1 Solanum Lycopersicum Colletidae Pollinator 1 The presence frequency shows frequency of interaction between arthropod and plant. Interaction can be distinguished into direct and indirect interaction. Indirect interaction occured between plant and predatory arthropod, such as spiders (Tetragnatha sp., Saltcicidae, and Lycosidae), whereas direct interaction occured between plant and herbivorous insect, includedpollinator. Interaction between plant and herbivorous insect which is pest of tomato plant is negative interaction, whereas interaction between pollinator insect and tomato plant is beneficial to both species (positive interaction, mutualism symbiotic).Table 1 shows that the most frequent present of interaction was between tomato plant (Solanumlycopersicum) and Aphididae family which isherbivorous insect (pest of tomato plant), whereas the most frequent pollinator presence wasXylocopavirginica.The picture of the interaction pattern can be seen in Figure 1. Plusia.sp Nephotettix.sp Ac hilidae P.moesta Helicov erpRa..sdporsalis Acrididae B.tabaci Aphididae S.litura X.v irginica C.rotundus S.ly copersicum FIGURE 1. Interaction pattern between herbivorous insect (including pollinator) and plant in the NPK fertilizer treatment (code PU) The interaction pattern in Fig. 1 explains that is wider bar is higher interaction frequency between the upper trophic level (herbivorous insect) and the lower trophic level (plant), so the figure shows that the interaction between Aphididae and tomato plant is the highest in frequency. In the vermicompost fertilizer treatment (code PC), the most frequently present on tomato plant was Aphididae which is pest of tomato plant. The presence frequency of Aphididae in the vermicompost treatment was higher than in the NPK fertilizer treatment (Table 2).Pollinator insects that interacted with tomato plants in this treatment were Xylocopa virginica and Apidae with frequency of each was one time during the observation period.The interaction pattern of between plant and herbivorous insect (including pollinator) in the vermicompost fertilizer treatment is presented in Figure 2. X.v irginic P.moesta AchilSidoageatella.sp D.maidis Aphididae Nephotettix.sp B.tabaciAcrididae S.litura Helicov erpa.sp C.rotundus S.ly copersicum FIGURE 2. Interaction pattern between herbivorous insect (including pollinator) and plant in thevermicompost fertilizer treatment (code PC) The interaction pattern in Figure 2 shows that the interaction between Aphididae and tomato plant was the highest in frequency, indicated by the widest bar compared to the others, while the dominant weed in the interaction pattern was similar to the NPK fertilizer treatment, i.e.Cyperusrotundus.This weed breeds generatively and vegetatively with rhizome and root tuber. Rhizomaand root tuber will grow into new plants if cut off during tillage or weeding. This is what makes this weed becomesdominant[4,5]. TABLE 2.Presence frequency of arthropod on plant canopyin thevermicompost fertilizer treatment (code PC) Visited plant Visiting arthropod Trophic Presence status frequency (times) Cyperus rotundus Coccinellidae Predator 4 Cyperus rotundus Acrididae Herbivore 4 Solanum lycopersicum Achilide Herbivore 3 Cyperus rotundus Libellulidae Predator 1 Cyperus rotundus Bemisia tabaci Herbivore 4 Solanum lycopersicum Libellulidae Predator 2 Solanum lycopersicum Acrididae Herbivore 19 Solanum lycopersicum Sogatella sp. Herbivore 2 Solanum lycopersicum Sarcophagidae Scavenger 1 Cyperus rotundus Syrphidae Predator 1 Solanum lycopersicum Proutista moesta Herbivore 1 Solanum lycopersicum Spodoptera litura Herbivore 11 Solanum lycopersicum Aphididae Herbivore 69 Solanum lycopersicum Dalbulus maidis Herbivore 2 Solanum lycopersicum Bemisia tabaci Herbivore 13 Solanum lycopersicum Formicidae Predator 7 Solanum lycopersicum Tetragnatha sp. Predator 2 Solanum lycopersicum Mantidae Predator 1 Solanum lycopersicum Helicoverpa sp. Herbivore 9 Solanum lycopersicum Nephotettix sp Herbivore 7 Solanum lycopersicum Curculionidae Predator 1 Solanum lycopersicum Syrphidae Predator 1 Cyperus rotundus Formicidae Predator 1 Solanum lycopersicum Chironomidae Predator 1 Solanum lycopersicum Salticidae Predator 2 Solanum lycopersicum Xylocopa virginica Pollinator 1 Solanum lycopersicum Apidae Pollinator 1 In the manure fertilizer treatment (code PK), the most frequentlypresent on tomato plant was also Aphididae.The frequency was lower than in the NPK and vermicompost fertilizer traetments (Table 3).Pollinator insect that interacted with tomato plant in the manure fertilizer treatment wereXylocopavirginica and Drosophila sp. withfrequency of each was 3 times and 1 time during observation period.The interaction pattern of between plant and herbivorous insect (including pollinator) in the manure fertilizer treatment is presented in Figure 3. Drosophil.sp Sogatella.sp X.v irgnica D.maidis S.litura Nephotettix.sp AcrididaeB.tabaci Aphididae Helicov erpa.sp Achilidae S.ly copersicum C.rotundus C.dacty lo FIGURE 3. Interaction pattern between herbivorous insect (including pollinator) and plant in themanure fertilizer treatment (code PK) TABLE 3.Presence frequency of arthropod on plant canopyin themanure fertilizer treatment (code PK) Visited plant Visiting arthropod Trophic Presence status frequency (times) Solanum lycopersicum Dalbulus maidis Herbivore 3 Solanum lycopersicum Acrididae Herbivore 12 Cyperus rotundus Braconidae Predator 1 Solanum lycopersicum Sarcophagidae Scavenger 1 Cyperus rotundus Acrididae Herbivore 7 Cyperus rotundus Oxyopes sp. Predator 2 Solanum lycopersicum Libellulidae Predator 4 Cyperus rotundus Dalbulus maidids Herbivore 2 Solanum lycopersicum Aphididae Herbivore 51 Solanum lycopersicum Spodoptera litura Herbivore 9 Solanum lycopersicum Bemisia tabaci Herbivore 10 Solanum lycopersicum Helicoverpa sp. Herbivore 10 Solanum lycopersicum Oxyopes sp. Predator 1 Cyperus rotundus Formicidae Predator 6 Ricardia scabra Formicidae Predator 2 Cyperus rotundus Coccinellidae Predator 4 Cyperus rotundus Libellulidae Predator 1 Cynodon dactylon Achilidae Herbivore 2 Cynodon dactylon Syrphidae Predator 1 Solanum lycopersicum Sogatella sp. Herbivore 2 Solanum lycopersicum Coccinellidae Predator 1 Solanum lycopersicum Syrphidae Predator 2 Solanum lycopersicum Chironomidae Predator 2 Solanum lycopersicum Nephotettix sp. Herbivore 2 Solanum lycopersicum Vespidae

Predator 1 Xylocopa Solanum lycopersicum virginica Pollinator 3 Solanum lycopersicum Drosophila sp Pollinator 1 The interaction pattern in Fig. 3 illustrates that the interaction between Aphididae and tomato plantwas the highest in frequency, indicated by the widest bar compared to the others, while the dominant weed in the interaction pattern wasCyperusrotunduswhich had 2 interaction links with herbivorous insect and Cynodondactylonwhich had 1 link interaction with herbivorous insect. In the compost fertilizer treatment (code PKm), the most frequently present on tomato plant was also Aphididae. The frequency was lower than in the vermicompost fertilizer treatment, but higher than in the NPK and manure fertilizer treatments(Table 4). Pollinator insect that interacted with tomato plant in the compost fertilizer treatment were Xylocopavirginica, Colletidae, and Megachilidae, with frequency of each was 4 times, 2 times, and 1 time during the observation period. Thus, Xylocopavirginicawas pollinator that was found in each treatment with the highest frequency compared to other pollinators. Xylocopa bee has an advantage to become pollinator insect because possess big body, able to fly fast and far in big wind, able to push closed petal, able to do buzzing, and able to visit many kinds of flower especially when its favourite flower is not present[6]. The interaction pattern of between plant and herbivorous insect (including pollinator) in the compost fertilizer treatment is presented in Figure 4. The interaction pattern in Fig. 4 explains that the interaction between Aphididae and tomato plant was the highest in frequency, indicated by the widest bar compared to the others, while the most dominant weed in the interaction pattern was Cyperusrotundus which had 3 interaction links with herbivorous insect. This is in accordance with Kalshoven'sstatement, that weed may have role as alternative host for insect pest[7]. Table 5 presents the result of network level analysis with the bipartite in R statistics program of four treatments with four indicators, i.e. number of higher trophic species, number of lower trophic species, interaction evenness, and Shannon diversity index. Helicov erpa.sp Nephotettix.s Sogatella.sp B.tabaci Megachilidae AcrididEamepoasca.sp X.v irginica D.maidis Achilidae S.litura Aphididae R.dorsalis C.rotundus S.ly copersicum FIGURE 4. Interaction pattern between herbivorous insect (including pollinator) and plant in thecompost fertilizer treatment (code PKm) TABLE 4.Presencefrequency of arthropod on plant canopyin thecompost fertilizer treatment (code PKm) Visited plant Visiting arthropod Trophic status Presence frequency (times) Cyperus rotundus Formicidae Predator 1 Cyperus rotundus Libellulidae Predator 1 Solanum lycopersicum Achilidae Herbivore 5 Cyperus rotundus Coccinellidae Predator 5 Cyperus rotundus Achilidae Herbivore 1 Solanum lycopersicum Sogatella sp. Herbivore 2 Solanum lycopersicum Acrididae Herbivore 11 Cyperus rotundus Acrididae Herbivore 7 Cyperus rotundus Dalbulus maidis Herbivore 2 Cyperus rotundus Camponotus sp. Predator 2 Solanum lycopersicum Aphididae Herbivore 63 Solanum lycopersicum Nephotettix sp. Herbivore 2 Solanum lycopersicum Spodoptera litura Herbivore 5 Solanum lycopersicum Curculionidae Predator 1 Solanum lycopersicum Plusia sp. Herbivore 2 Solanum lycopersicum Bemisia tabaci Herbivore 3 Solanum lycopersicum Recilia dorsalis Herbivore 1 Solanum lycopersicum Helicoverpa sp. Herbivore 11 Solanum lycopersicum Salticidae Predator 2 Solanum lycopersicum Coccinellidae Predator 1 Solanum lycopersicum Dalbulus maidis Herbivore 2 Solanum lycopersicum Sarcophagidae Scavenger 1 Solanum lycopersicum Empoasca sp. Herbivore 1 Solanum lycopersicum Xylocopa virginica Pollinator 4 Solanum lycopersicum Colletidae Pollinator 2 Solanum lycopersicum Megachilidae Pollinator 1 The number of higher trophic level is number of herbivorous insect involved in interaction with plant, indicating the richness of herbivorous insect. Comparing among four treatments, the highest richness of higher trophic level was in the compost fertilizer treatment and the lowest was in the manure fertilizer treatment. TABLE 5. Results of network level analysis with bipartite in R statistics program Num Indicators Treatment codes PU PC PK PKM 1 Number of higher trophic species 14 12 11 2 Number of lower trophic species 2 2 3 3 Interaction evenness 0.76 0.69 0.75 4 Shannon diversity index 2.15 1.84 1.91 15 2 0.67 1.94 Note: PU = NPK fertilizer treatment PC = vermicompost fertilizer treatment PK = manure fertilizer treatment PKM = compost fertilizer treatment Number of lower trophic species is number of plant species involved in interaction with herbivorous insect, indicating the richness of plant. Table 5 shows that the highest richness of lower trophic level was in the manure fertilizer treatment, whereas in the other treatmentswere same. Interaction evenness is uniformity measurement of energy flow from many different interaction paths. Habitat modification causes major difference in interaction evenness, thus it affects network structure[1].Interaction evenness is number which indicatesevenness level of interaction[8,9], so in the interaction pattern between herbivorous insect and plant, higher number indicates the higher evenness level of interaction of between herbivorous insect and plant. Table 5 shows that the highest interaction evenness was inthe NPK fertilizer treatment, and the lowest is in the compost one. Shannon diversity is number of biodiversity indexin both upper and lower trophic levels ininteraction structure (network) based on Shannon formula. The higher number of Shannon index indicates the higher level of biodiversity, in this case is biodiversity of plant and herbivorous insect. The Shannon index is the most commonly used in community ecology. This value will rise as the number of species increases and the individual distribution of species is more evenly. The diversity has an effect on interspecific interaction in direction and magnitude[10].Ecosystem with higherbiodiversity usually has longer and more complex food chains, which hasmuch more interaction like predation, parasitism, commensalism, mutualism, and so on. The negative feedback control of the interaction will control the shock that occur so that the ecosystem runsmore stable[11].Table 5 shows that the NPK fertilizer treatment hasthe highest Shannon diversity and interation evenness than other treatments, so it is possible that this treatment has more stable network structure. Frequency and Longevity of Pollinator Insect Visitation on Tomato Plant Pollinator insect visitation is influenced by bottom-up mechanisms, i.e.soil nutrient will affect plant performance, including chemical content of nectar, and will ultimately affect visitation of pollinator insect. Ecologically, the interaction between pollinator insect and plant is influenced by many factors, including plant diversity [12,13], and abiotic factors, eg temperature[14]. Both factors influence the interaction through nutrient availability and appropiate microclimate mechanisms for plant, which in turn will affect nectarproduction that will attract pollinator insect to visit. Therefore, to determine whether there is a bottom-up mechanism in this study, it needs to check the chemical analysis result of soil samples, which is presented in Table 6. TABLE 6. Chemical analysis of soil samples before and after treatment Parameters Before treatment After treatment PU PK PKM pH H2O 7.13 6.87 6.96 6.60 OrganicC (%) 0.85 1.23 1.01 0.81 Total N (%) 0.06 0.12 0.12 0.10 C/N ratio Not analysed 10.7 9 8 Organic matter (%) Not analysed 2.11 1.75 1.4 PC 6.63 1.20 0.09 13 2.08 Note: PU = NPK fertilizer treatment PC = vermicompost fertilizer treatment PK = manure fertilizer treatment PKM = compost fertilizer treatment Table 6 shows the following facts. The C / N ratio analysis shows that the manure and compost used were categorized as "immature", while the vermicompost fertilizer was categorized as “mature”. That is, manure and compost might not be able to provide the nutrient that plant needed as well as vermicompost fertilizer.Analysis of organic matter shows the same pattern, that wasorganic matter in manure and compost were lower than vermicompos and NPK fertilizers. Table 7 presents the result of laboratory test on nectar samples including pH, reducing sugar, total sugar, and sucrose. TABLE 7.Result of laboratory test on chemical content of tomato flower nectar samples Parameters NPK Manure fertilizer Vermicompost Compost fertilizer treatment fertilizer treatment fertilizer treatment treatment (code PK) (code PC) (code PKM) (code PU) pH 5.53 5.56 5.59 5.53 Reducing sugar 0.1524 0.2054 0.1973 0.1950 (%) Total sugar (%) 1.4695 1.8442 1.8135 1.7338 Sucrose (%) 1.2512 1.5568 1.5354 1.4619 Table 7 shows that the content pattern of sugar and sucrose of nectar did not correspond to the pattern of C/N ratio and organic matter of soil in Table 6. The content of reducing sugar and total sugarwere much more in the manure and vermicompostfertilizer treatments than in the NPK and compost fertilizer treatments. Similarly, the percentage of sucrose. OrderHymenoptera or the colony of bees is main pollinator on farming plants,yet has been used and developed in many countries. ResearchedbyFajarwati, Atmowidi, andDorly on or-ganic farming land showedthat the most frequent insects to visit tomato flower are fromorderHymenoptera, thenDiptera, Lepidotera, Thysanoptera, Hemiptera, and Homoptera[15]. Figure 5 shows that pollinator insects from Hymenoptera order (Xylocopavirginica, Colletidae, Megachillidae, and Apidae) more visited than the Dipteraorder(Drosophila). This figure also shows that the frequency sequence of pollinator insect visitation on tomato plant flowerwasin plots fertilized with NPK (PU)> compost (PKM)> manure (PK)>vermicompost (PC). This result did not correspond to the sugar and sucrose content of tomato plant flower of each treatment (Table 7). 9 8 7 6 FrekNuPeKnsfeirPtiulizpeurktreNatPmKen(PtU) 5 (code PU) 4 3 Frekuensi Pupuk Kandang 2 (PK) 1 Compost fertilizer treatment 0 Frekuensi(PcoudpeuPkKK)ompos (PKM) Vermicompost fertilizer FrekuterenastmiPeuntp(ucokdKePaCsc)ing (PC) FIGURE 5.Presence frequency of pollinator insects in each treatment. Figure 6 shows that longevity of pollinator insect visitation followed the same pattern as in Figure 5. The longest visitation was in NPK fertilizer treatment (PU), followed by compost (PKm), manure (PK) and theshortestwas in vermicompost fertilizer treatment(PC). 80 70 60 ToTtoatallLloonnggeevivtiyty(se(cdoentdi)k) 50 PuopfNukPKNtPreKat(mPeUnt) (PU) 40 30

ToTtoatallLloonnggeevivtyit(yse(cdoentdi)k) 20 PuofpmukanKuraentdreaatnmgen(Pt(KP)K) 10 0 TofoctaolmLloopnongsgetevtrivteyiatt(ymsee(cdnotentdi)k) Pu(PpKumk)Kompos (PKM) TotalLloonnggeevvitiyty(s(edcoentdik)) PuotprfeuvatekmrmKenaictso(cmPiCnp)ogst(PC) FIGURE 6. Longevity of pollinatorinsect visitation in each treatment The analysis result of nutrient soil (Table 6), sugar and sucrose contents of nectar (Table 7), and the interest of pollinator insect embodied in frequency and longevity of visitation indicate a non-conformity relationship. Munoz, et al.showed that nutrient added to the plant had a significant effect on the frequency of pollinator insect visitation, although the result was obtained after the system was constructed in several growing seasons[16].In this case, the pollinator insect requires "habituation" to recognize the host plant as its habitat. According toFerdy, et al.,pollinator insects also use effort of learning to understand the condition of host plant as habitat, so it takes time[17].Therefore, this research may not yet be able to show a linear relationship between nutrient used in planting media (type of fertilizer), tomato plant flower quality (sugar and sucrose contents), and acceptance by pollinator insect (frequency and longevity of visitation). That is, the system takes more time to prove that the addition of soil nutrient can affect the interest of pollinator insect in plant. Furthermore, Faegri and Van der Pijl explain that the relationship between plant and visitor (pollinator insect) interest is determined by various teasers, including feed ingredient that may be found in flower (pollen, nectar, water, etc.),seductive odor, and sexually attractive form of flower[18]. Therefore, this research is interesting to be continued, especially to find out sources of teaserfor pollinator insect to visit flower of tomato plant. CONCLUSION 1. The mutualism interaction pattern of plant-pollinator network of four treatments were varied. 2. The pattern of plant-pollinator network of NPK fertilizer treatment showed the more stable interaction in one growing season, based on analysis of interaction evenness, Shannon diversity, frequency and longevity of pollinator visitation. ACKNOWLEDGMENT The authors thank to the Institute of Research and Community Service of Yogyakarta State University and Directorate General of Higher Education of Ministry of Research, Technology, and Higher Education due to the funding for this research in 2015. REFERENCES 1. J.M.Tylianakis, T. Tscharntke, and O.T. Lewis, Habitat Modification Alters the Structure of Tropical Host- Parasitoid Food Webs. Nature. Letters, Vol 445/11 January 2007/doi:10.1038/nature05429, 202-205, (2007). 2. M.J.O. 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