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Role of spider *Oxyopes birmanicus* (Araneae: Oxyopidae) in management of cowpea aphid *Aphis craccivora* (Homoptera: Aphididae)

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Abstract
Predation is of incredible biological, transformative and conducts intrigue. For the present research, the essential explanation behind considering it is to decide the job of spider in management insect pests in field crops. A trial was directed in Biocontrol lab. of Jawaharlal Nehru Krishi Vishwavidyalaya Jabalpur (M.P.) India. For resolving the category of functional response in spider - *Oxyopes birmanicus* (Araneae: Oxyopidae) exists as the test predator on prey, *Aphis craccivora* (Homoptera: Aphididae) that is revealed as type II response. The trial was led in CRD where different densities of *A. craccivora* are taken as treatments for Analysis of Variance. Treatments found to be significant at 5% level of significance. The consumption rate of spider belonging from oxyopidae ranges from 9±1 on a mean; our estimate of the utmost predation percentage of *A. craccivora* attacked in 24 hours was 95% for both the trails of *O. birmanicus*.

Keywords: Spiders, predator behavior, prey, aphid, functional response, population density

Introduction
Order Araneae is a large group of predatory spiders. Among the wonders of nature, there are few things more remarkable than these agile eight-legged creatures, often beautiful in structure, with striking habits and complex life histories [3]. Over 48372 spider species having a place with 120 families and 4164 genera are known presently [27]. This characteristic control is a usage of a natural idea called "community stability". The spiders suck the sap of prey and their soft abdomen to make it easy for them to devour a lot of its prey in a moderately brief span, making it foremost biocontrol agent [21, 26]. In Organic cropping, a combination of natural enemies in augmentation biological control programs may offer control of a set of co-occurring pests, earlier colonization and higher efficacy to reduce high numbers of pests [1]. Therefore, laboratory studies exploring "biological control potential" offer valuable insights in the optimization of biological control strategies. Spiders of numerous families are usually present in agroecosystem and have been reported as predators of insects [4, 22]. The existing discoveries uncovered that araneid fauna as a proficient predator of sap feeders could be utilized for containment of insect pests of Cotton [9]. The cosmopolitan polyphagous cowpea aphid, *A. craccivora* Koch, (Hemiptera: Aphididae) is the key pest of bean crops. Certainly, causes significant yield loss, due to the transmission of two viruses viz., Faba bean necrotic yellows virus and Bean leaf roll virus [12], business losses due to honeydew secretion on the pods making them unsalable [10]. Despite its key the role in the management of insect pest population, their predatory competence is of interest in crop fields which has not been thoroughly explored [8]. The point of leading the current examination is to investigate the savage capability of spider *Oxyopes birmanicus* due to its plenitude in the field crops [22] past the mark of being a generalist predator of the pests in any agroecosystem and at the extent of degree it tends to be considered as a proficient biological control specialist for the integrated pest management programme.

Materials and Methods
This research was led to the Biocontrol laboratory. The experiment was carried out using two trails of completely randomized design of 6 treatments as aphid densities and 10 replicates (Table. 1) and a control treatment along with each treatment to evaluate the corrected mortality due to spiders by adopting the methodology of [7].

Aphid, *A. craccivora* Koch was raised on cowpea plants. The field collection of hundred adult female spiders (*O. birmanicus*) about similar size & weight were starved to 24 hrs utilized for their investigation as test predators. Nymphs of *A. craccivora* (24 hours old) on cowpea twigs were used as prey of the spider. Single predator/ jar were assigned to the prey. Jar set was kept under ambient conditions *i.e*. $25^0 \pm 2\ ^0C$ and 80 ± 10% RH. Concurrently, a control set of all the treatments were also considered which contained a varying population of aphid nymphs but without a spider, to work out the biological mortality of the prey. After 24 hr the total of live aphids left in every jar be documented and the predation percentage was worked out.

Statistical analysis

The data were exposed to the analysis of variance (ANOVA) [19] at 5% level of significance. Further data were tested by Duncan's multiple range test using the formula as suggested by [5].

The type of functional response was resolved by utilizing logistic regression examination of the extent of consumed prey against the preliminary number of prey accessed for maximization of the probabilities. To do this, data were fitted to a polynomial logistic regression equation [7]:

$$\frac{N_e}{N_0} = \frac{P_0 + P_1N_0 + P_2N_0^2 + P_3N_0^3}{1 + \exp\left(P_0 + P_1N_0 + P_2N_0^2 + P_3N_0^3\right)}$$

Ne expresses the number of prey consumed, No represents the initial prey density and P_0, P_1, P_2, P_3 are the intercept, linear, quadratic and cubic coefficients, respectively.

Result

Studies on the functional response give imminent into the appropriateness of a spider as a biocontrol agent. *A. craccivora* is a major pest of bean crops and can be viewed as the chief prey for the spider. The consumption rate of the spider belonging from Oxyopidae ranges from 9±1 prey per day on an average (Table. 3); our estimates of extreme predation percentage of *A. craccivora* damaged in 24 h were 95% for both the trails of *O. birmanicus* (Table. 2) For a predator to be effective in the field, the feeding rate has to increase with the increase in the prey density.

The data presented in table 2 and 3 are representation of both the trials along with the pooled one which revealed that the *A. craccivora* consumed by a single *O. birmanicus* at different aphid density ranged from 8.7 aphids/day (T_2) to 9.0 prey/day (T_6), but were found to be non significant. Maximum predation (95.83%) was recorded in T_1 and was significantly superior to all other treatments. This was followed by T_2 (49.88%), T_3 (24.18%), T_4 (12.35%), T_5 (6.06%) and minimum in T_6 (3.24%) and they differed significantly from each other.

The consumption rate of spider found to remain same irrespective the numbers of *A. craccivora* provided as a spider can feed according to its feeding capacity only depending upon its abdominal size. Predation by a spider is density-dependent which is affected by two characteristics *i.e*. feeding and hunting behaviour which can be learned from functional response. In experiments, the number of aphids consumed by spider *O. birmanicus* (F-Oxyopidae) was found to increase with increasing aphid densities at a decreasing rate (Tables. 4). The linear coefficient i.e., P1 in the polynomial logistic regression of the extent of aphid attacked versus starting density was negative for the spider along with a positive quadratic parameter depicted as P2 a type II functional response.

Discussion

The existing investigation on the functional response of *O. birmanicus* on *A. craccivora* revealed that predatory potential varies from 95% maximum and 3% minimum which is following [7, 23]. Advance modifications of body parts of spider established them superior predators [29]. The assessment of the linear regression concerning the predation percentages of the *O. birmanicus* on *A. craccivora* versus density was found to be negative. The polynomial logistic regression demonstrated that spider exhibited type II functional response with the diminishing proportion of prey intake along with the increasing densities of cowpea aphids and similar results are reported by [7, 25]. This type of response is often called ‘invertebrate curve’ and undoubtedly seems to be frequent in spiders [17, 14]. Whereas, type III functional response was reported by another group of a spider against aphid and tobacco caterpillar by [23, 26] in laboratory studies. Spiders have the most elevated prey searching skill and they guzzle a more noteworthy measure of prey than other field inhabiting biocontrol agents [13].

[15] Evaluated the intake capability of predatory spider species on cotton in the research centre and found that predatory potential of the green lynx spider, *P. viridana* increased with the stage of the spider for all the cotton pests. Among the sucking pests of cotton, *P. viridana* and *C. drassodes* showed equal preference to aphids the adult spider consumed 3.34-7.34 aphids/day [16] and 1-8 aphids per day by spider *Hyllus semicupreus* [24] which is in accordance to the present study. Spiders might be influential mortality operators of field pests such as aphids, leafhoppers, plant hoppers, flea hoppers, and Lepidoptera larvae [28].

Nevertheless, different components for predatory behaviour, for example, the science of prey and predator, including host inclination, thrashing behaviour, intrinsic development rates, the intake rate of a predator, preying nature, prey patchiness, their host plant, the impact of biotic and abiotic factors, intra and interspecific antagonism could be significant consequences for the capacity of an organic management driving force in dealing the population of insect pests [20, 18, 11, 2, 6].

Table 1: Treatment details

Tr. Code	Treatment (*A. craccivora* /jar)
T_1	10
T_2	20
T_3	40
T_4	80
T_5	160
T_6	320

Tr. = Treatment

Table 2: Impact of *A. craccivora* population density on predation by *O. birmanicus* under in vitro conditions

Tr. Code	Mean predation of *A.*	*craccivora* by *O.*	*birmanicus* (%)
	Trial I	Trial II	Pooled
T_1	95.88 (83.55) a	95.77(82.41) a	95.83(78.22)a
T_2	49.64 (44.79) b	50.13(45.07) b	49.88(44.93)b
T_3	24.29 (29.49) c	24.08(29.36) c	24.18 (29.46)c
T_4	12.37 (20.56) d	12.33(20.53) d	12.35(20.57)d
T_5	6.09 (14.18) e	6.03(14.16) e	6.06(14.25)e
T_6	3.20 (10.14) e	3.28(10.29) e	3.24(10.37)f
SEm±	1.52	1.43	1.28
CD at 5%	4.33*	4.08*	3.65*

Temperature 25± 2 ºC and RH 80± 10%
RH = Relative Humidity
Tr. = Treatment
SEm = Standard error of mean
CD = Critical Difference
± = plus or minus
* = Significant at 5%
%= Percent
( ) Figures in parentheses are arcsin transformed values
Means in a column followed by same letter do not differ significantly (DMRT < 0.05)

Table 3: Impact of *A. craccivora* population density on consumption by *O. birmanicus*

Treatments	Mean number of *A. craccivora* consumed by *O. birmanicus*/ day		
	Trial I	Trial II	Pooled
T_1	9.00 (17.45)a	8.90 (17.35)a	8.95(17.4)a
T_2	8.70 (17.15)ab	8.70 (17.15)ab	8.70 (17.15)ab
T_3	8.90 (17.35)b	8.90 (17.35)ab	8.90 (17.35)b
T_4	8.90 (17.35)ab	8.80 (17.25)b	8.85(17.3)b
T_5	8.0 (17.25)ab	8.80 (17.25)ab	8.8(17.25)ab
T_6	9.10 (17.55)ab	8.90 (17.35)ab	9.0 (17.45)ab
SEm±	0.20	0.20	0.18
CD at 5%	NS	NS	NS

Temperature 25±2 °C RH 80±10 %
RH = Relative Humidity
Tr. = Treatment
SEm = Standard error of mean
CD = Critical Difference
NS= Non significant
± = plus or minus
* = Significant at 5%
%= Percent
( ) Figures in parentheses are arcsin transformed values
Means in a column followed by same letter do not differ significantly (DMRT < 0.05)

Table 4: Logistic regression analysis of the proportion of prey *A. craccivora* devoured by *O. birmanicus* against initial number of *A. craccivora* offered

Spider species	Trial I					Trial II				Pooled			
	Coeff	EST	SD	Chi^2	$Pr(>\vert Chi^2\vert)$	EST	SD	Chi^2	$Pr(>\vert Chi^2\vert)$	EST	SD	Chi^2	$Pr(>\vert Chi^2\vert)$
O. birmanicus	P_0	1.31	0.08	294.5 2	<0.0001	0.67	0.16	18.57	< 0.0001	1.2	0.12	101.48	< 0.0001
	P_1	-1.68	0.18	91.42 0	<0.0001	-1.24	0.29	180	< 0.0001	-0.08	0.21	0.14	0.71
	P_2	3.02	0.51	35.40	<0.0001	5.90	0.87	45.87	< 0.0001	1.87	0.65	8.18	0.004
	P_3	-0.92	0.35	7.09	0.008	-4.78	0.59	65.10	< 0.0001	-2.38	0.45	27.39	< 0.0001

Coeff = Coefficient
EST = Estimate
SD = Standard deviation
Chi^2 = Chi-square
Pr = Probability
P_O = Constant
P_1= Linear
P_2= Quadratic
P_3= Cubic

Conclusion

The interactions of spiders and their prey have been investigated systematically. The findings conclude that spider *O. birmanicus* is an efficient biocontrol agent against pest and registered type II functional response with 95% consumption rate. As this spider is the natural enemy of pest and found abundant in the field need to be conserved by protecting its guilds.

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Reference
1. Devee A, Arvaniti K, Perdikis D. Intraguild predation among three aphidophagous predators. Bulletin of Insectology. 2018; 71(1):11-19.
2. Farhadi R, Allahyari H, Juliano SA. Functional Response of larval and adult stages of *Hippodamia variegata* (Coleoptera: Coccinellidae) to different densities of *Aphis fabae* (Hemiptera: Aphididae). Environmental Entomology. 2010; 39(1):1586-1592.
3. Gajbe PU. Spiders of Jabalpur, Madhya Pradesh (Arachnida: Araneae). Rec. of the Zoological Survey of India. Occasional Paper. 2004; 227:1-144.
4. Geetha N, Gopalan M. Effect of interaction of predators on the mortality of nymphs of brown planthopper, *Nilaparvata lugens* Stal. Journal of Entomological Research. 1999; 23(1):179-181.
5. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. Publ. John Wiley and Sons. Inc., New York, 1984, 361-388.
6. Khan AA. Functional Response of Four Spiders, *Pardosa altitudis* Tikader and Malhotra, *Teragnatha maxillosa* Thorell, *Neoscona mukherjei* Tikader and *Theridion* sp. to Rice Grass Hopper. Oryza. 2012; 49(1):39-44.
7. Khan AA. Assessment of Predation Capability of Four Species of Spiders (Arachnida: Araneae) to Green Apple Aphid, *Aphis pomi* De Geer (Homoptera: Aphididae). International Journal of Ecology & Environmental Science. 2016; 42(1):9-16.
8. Khan AA, Rather AQ. Diversity And Foraging Behavior of Spider (Arachnida: Araneae) In The Temperate Maize Ecosystem of Kashmir. Journal of Biological Control. 2012; 26(1):179-189.
9. Khuhro R, Ghafoor A, Baloch NA. Assessment of Potential of Predatory Spiders in Controlling the Cotton Jassid (*Amrasca devastans*) Under Laboratory Conditions. The Journal of Animal & Plant Sciences. 2012; 22(1):635-638.
10. Laamari M, Khelfa L, Coeur d', Acier A. Academic Journals Resistance Source to Cowpea Aphid (*A. Craccivora* Koch) in Broad Bean (*V. Faba* L.) Algerian Landrace Collection. African Journal of Biotechnology. 2008; 14(1):2486-2490.
11. Nilsson PA. Predatory Behaviour and Prey Density: Evaluating Density-Dependent Intraspecific Interactions on Predator Functional Responses. Journal of Animal Ecology. 2001; 70(1):14-19.
12. Oufroukh A. Les Principales Viroses Limitant La Culture De La Fève (*Vicia faba* L.) En Algérie Et Principes De Lute Journées Sur Les Ennemis Et Les Parasites De La Fève: Recueil Des Communications Orales. 1997; 23(1):8-16.
13. Regev EG, Rotkopf R, Lubin Y, Coll M. Consumption of aphids by spiders and the effect of additional prey: evidence from microcosm experiments. Biological Control. 2009; 54(3):341-350.
14. Samu F, Biro Z. Functional Response, Multiple Feeding and Wasteful Killing in Wolf Spider (Araneae: Lycosidae). European Journal of Entomology. 1993; 90(1):471-476.
15. Sebastian PA, Sudhikumar AV. Feeding Potential of Spiders (Order: Araneae) on *Aphis craccivora* Koch Occurring on Cotton. Entomon. 2003; 28(1):153-156.
16. Sivasubramanian P, Vanitha K, Kavitharaghavan Z, Banuchitra R, Samiayyan K. Predatory potential of different species of spiders on cotton pests. Journal of Farm Sciences. 2009; 22(3):544-547.
17. Smith R, Wellington WG. The Functional Response of a Juvenile Orb-Weaving Spider. In: Proceeding of 9th International Congress of Arachnology. Smithsonian Institute Press, Panama, 1983, 275-279.
18. Snyder WE, Wise DH. Predator Interferences and the Establishment of Generalist Predator Populations for Biocontrol. Biological Control. 1999; 15(1):283-292.
19. Steel RGD, Torrie JH. Principles and Procedures of Statistics: A Biometrical Approach 3rd Edi. Mcgraw Hill Book Co., Inc., New York, 1997, 35-46.
20. Sunderland KD. Field and Laboratory Study on Monkey Spiders (Linyphidae) as Predator Cereal Aphid. Journal of Applied Ecology. 1986; 23(1):433-447.
21. Umarani S, Umamaheswari S. Spiders are of Economic Value to Man. Journal of Entomology Research. 2013; 37(1):365-368.
22. Upadhyay J, Das SB, Chakrabarti S. Diversity of spiders on post rainy season crops in Jabalpur, Madhya Pradesh. Journal of Entomology & Zoology Studies. 2018a; 6(3):1645-1650.
23. Upadhyay J, Das SB, Chakrabarti S. Predatory potential of spider, *Synema decoratum* (Araneae: Thomisidae) on aphid, *Aphis craccivora* (Homoptera: Aphididae). International Journal of Fauna & Biological Studies. 2018b; 5(5):03-07.
24. Upadhyay J, Das SB, Chakrabarti S. Functional response of spider, Salticidae (*Hyllus semicupreus*) on aphid, *Aphis craccivora* (Homoptera: Aphididae). International Journal of Zoology Studies. 2018c; 3(5):20-24.
25. Upadhyay J, Das SB. Functional Response of Spider *Hyllus semicupreus* on *Spodoptera litura*. Indian Journal of Entomology. 2020; 82(2):257-260.
26. Upadhyay J, Das SB, Chakrabarti S. Biological Control Perspective of *Synema decoratum* (Araenae: Thomisidae) against *Spodoptera litura* (Lepidoptera: Noctuidae). International Journal of Current Microbiology & Applied Sciences. 2020; 9(6):221-227.
27. World Spider Catalog. Version 20.5 Natural History Museum Bern. Online at http://wsc.nmbe.ch, version 18.5, accessed 24 March, 2020. doi: 10.24436/2
28. Yadav A, Chaubey SN, Beg MA. Studies on the role of *Hippasa holmerae* Thorell (Garden Wolf spider) as biocontrol agent for insect pests of crop fields collected from Azamgarh and Mau districts (U.P.) India. Journal of Experimental Zoology. 2012; 15(2):495-498.
29. Yang T, Liu J, Yuan L, Zhang Y, Li D, Agnarsson I, *et al.* Molecular identification of spiders preying on *Empoasca vitis* in a tea plantation. Scientific Report. 2017; 7(1):7784-7788.