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Research Article

Power packed green lacewing feed (PPGF), its shelf life and effect on reproductive potential of *Mallada desjardinsi* (Navas) (Neuroptera: Chrysopidae)

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ABSTRACT: A semi-synthetic diet named as the power packed green lacewing feed (PPGF), comprising whey protein, soybean granules, proteinex powder and glucon mixed in equal quantity by weight, was developed for *Mallada desjardinsi* (Navas) for increasing its reproductive potential. The cost of 1000g PPGF was worked out to be Rs. 621.00 (approx. US $14). It had a shelf life of four months at 5-10°C. The females of *M. desjardinsi* survived for 49 days when fed on the diet stored for eight weeks, on par with the control (58 days). Thereafter, survival declined to the lowest (16.8 days) when fed with the diet stored for 15 weeks. The predator laid maximum eggs (811.2 / female) on the diet stored for four weeks, on par with that on diet stored up to eight weeks (774 eggs / female) and the control (888 eggs / female). The fecundity declined to the lowest (220.6 eggs) on PPGF stored for 15 weeks. Per cent hatchability was on par for up to eight weeks and declined significantly, with 33% on the diet stored for 15 weeks. In PPGF+honey (20%) feed combination, another peak of egg laying was recorded in females after 4th week, whereas egg laying ceased in females that were fed with only 20% honey after the 4th week. The females survived for up to 9 weeks maintaining productive age of more than eight weeks. PPGF+honey (20%) offered to the adults of *M. astur* also enhanced the fecundity (668.0) as against the control (292.14). Besides, other biological attributes were not affected due to the feeding on PPGF. These studies suggest a great potential for commercialization of PPGF in order to promote cheaper production and field utilization of green lacewings.

KEY WORDS: PPGF, multiplication, *Mallada desjardinsi, M. astur,* shelf life

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INTRODUCTION

Chrysopids, commonly known as green lacewings (Neuroptera: Chrysopidae), have attracted considerable attention worldwide in recent years for mass production and use in biological control programmes. This is because of their widespread distribution and great potential in controlling a large number of insect pests and mites in different crops and cropping systems (Jalali and Singh, 1944; Gautam and Tesfaye, 2002; Gautam *et al.,* 2003; Pathan *et al.,* 2010). The larvae are predatory while adults feed on honeydew and a variety of flowers and thus get nutrition through nectaries and pollen grains. It may be noted that assured supply of pollen grains from plant sources is not only associated with seasonal dependence but also cumbersome (Gautam, 2008). Similarly, collection of honeydew from homopterans is practically not economical and advisable. Several semi-synthetic media, pollen grains and honey combinations advocated by various workers (Vanderzant, 1973; Gautam and Paul, 1988; Cohen *et al.,* 1998; Tesfaye and Gautam, 2002a; Ulhaq *et al.,* 2006; Senthilkumar and Gautam, 2007; Milevoj, 1999; Venkatesan *et al.,* 2000) do support the rearing of the predators with varying success. In view of that, a successful semi-synthetic diet was developed through a series of rigorous exercises to feed the green lacewing adults in the Plant Health Clinic of the Division of Entomology, Indian Agricultural Research Institute, New Delhi 110 012, India, and labeled as Power Packed Green lacewing Feed (PPGF). The cost of 1000g PPGF was worked out to be Rs. 621.00 (approx. US $14) based on the price index for the year 2006.

Keeping in view its potential for commercialization, studies on the shelf life of PPGF and its effect on the reproductive potential (female longevity, fecundity and egg hatchability) of *Mallada desjardinsi* (Navas) were conducted. Besides, potential of PPGF to induce egg laying of the predator was also studied as normally females feeding on honey alone become unproductive and cease oviposition between 3rd and 4th weeks after emergence.

MATERIALS AND METHODS

Basic ingredients of PPGF based on protein, fat, carbohydrate, essential minerals, vitamins and anti-oxidants easily available in any Indian market on reasonable price were purchased from the local market. These were weighed, mixed in an equal quantity and blended into powder. A semi-synthetic medium entitled Power Packed Green lacewing Food ("PPGF") consisting of whey protein (Wellspring, manufactured by Vending Updates (I) Ltd, New Delhi) and locally available soybean granules, proteinex powder and glucon was prepared. The thinly powdered PPGF was stored at 5°C in the refrigerator and offered to the adult green lacewings in order to see its influence as an adult food supplement on the reproductive potential of the predator. Newly emerged adults of *M. desjardinsi* from 5th generation were separated, sexed and kept in pairs in glass vials (4 x 7 cm) covered with black cloth. Influence of four adult food supplements, *viz.,* PPGF + 20% honey solution; PPGF + water; castor pollen grains + 20% honey solution on the biological attributes of the predator was studied and compared with control (20% honey solution).

A part of the medium was taken at weekly interval from one week to fifteen weeks, and offered to the freshly emerged adults of *M. desjardinsi* along with honey solution (20%) dipped in an absorbent cotton swab, in five replications. PPGF was immediately placed back in the refrigerator after taking out the required quantity. Observations on female longevity, fecundity and egg hatchability were recorded. A control was kept, where the medium prepared on weekly basis and stored at room temperature was offered to the predator.

In another experiment, 50 newly emerged females reared on frozen grubs of *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae), were kept in clear plastic containers (20 x 15cm) as per Elsiddig *et al.* (2006) and Tesfaye and Gautam (2002b). In each container, 25 adults were provided with a honey swab (20%) and castor (*Ricinus communis*) pollen as suggested by Gautam and Paul (1988). After a week, the adults were separated into pairs and kept in individual glass vials (5 x 10cm) and provided with honey (20%) alone for egg laying till the end of 4th week. No additional castor pollen was offered during these three weeks, while honey was provided on alternate days. At 4th week, PPGF + honey (20%) was offered to the adults in a set containing five replications till their death. A similar set of adults having five replications was kept as the control. The experiment was conducted at 25 ± 1°C and 60 + 5% RH. Observations on fecundity and egg hatchability were recorded for *M. desjardinsi* and *M. astur* (Banks).

RESULTS AND DISCUSSION

The prepared medium had a good shelf life of more than three months and was accepted by the predator as evidenced from the longevity and fecundity of females and egg hatchability (Table 1). Observations on the longevity of female revealed that the predator survived for almost 48.6 days when fed on stored PPGF + Honey (20%) for eight weeks and was at par with control. Thereafter, it declined to the lowest (16.8 days) in the treatment where medium was stored for fifteen weeks. Honey was found essential to enhance the longevity of the predator in the present investigation, and is in conformity with Gautam and Paul (1987 and 1988). However, it failed to induce fecundity which may be due to the fact that predator requires more protein for its ovarian development Interestingly, the predator's maximum fecundity was noticed up to 1012 on PPGF + Honey (20%) as against minimum of 300 when fed on the castor pollen grains, a natural protein source+ Honey (20%) when predator population was collected from cotton field (unpublished). Castor pollens along with honey are widely used for feeding the green lacewings as recommended by Gautam and Paul (1988) in case of another green lacewing, *Chrysopa scelestes* Banks. It may be noted that the predator laid 511 eggs even when PPGF was cold stored for a period of 12 weeks. Thereafter, it declined to the lowest (220.6 eggs / female) in the treatment where medium was stored for fifteen weeks. Adult chrysopids, in general, require a diet rich in protein, besides carbohydrates and other nutrients (Burke and Martin, 1956; Vanderzant, 1973; Rousset, 1980; Williams, 1999).

Interestingly, when PPGF + Honey (20%) was offered to the non-egg laying females in the 4th week, the egg laying resumed and there was normal egg hatching and another peak (second) was observed in the 7th week as against 1st narrow peak in the 2nd week when reared without PPGF (Fig. 1). The females enhanced their productive age to more than eight weeks and survived up to the 9th week. Females fed on honey (20%) alone also survived up to nine weeks but egg laying and hatching declined in the 4th week. These females did not lay eggs from the 5th week onwards and became totally unproductive (Figs. 1, 2). There was no significant difference in hatchability during the peak egg laying when fed on different diets (Fig. 2). PPGF + honey (20%) offered to the adults of *M. astur* also enhanced the fecundity (668.0) as against the control (292.14). Besides, other biological attributes were not affected due to feeding on PPGF (Table 2).

It may be concluded that PPGF is a better feed for *M. desjardinsi* and *M. astur* as it enhances the fecundity of females much beyond their effective oviposition period. Hence, PPGF may be explored for many other natural enemies in mass production. Based on the present study, it may be concluded that this semi-synthetic medium has potential to bring down the cost of mass production of the predator due to its good shelf life. These studies suggest a great potential for commercialization of PPGF in order to promote production and field utilization of green lacewings.

Table 1. Effect of cold stored semi-synthetic medium (PPGF) on some biological attributes of *M. desjardinsi*

Storage week	Reproductive attributes of the predator		
	Female longevity (days)	Fecundity (days)	Egg hatchability (%)
First week	61.8 ± 6.91	777.8 (27.88)	87.98 (70.89)
Second week	53.6 ± 13.09	803.6 (28.30)	87.94 (70.06)
Third week	48.0 ± 8.96	800.8 (28.22)	85.16 (67.47)
Fourth week	45.2 ± 9.32	811.2 (28.35)	77.95 (62.53)
Sixth week	49.6 ± 9.30	751.4 (27.38)	81.80 (64.99)
Eighth week	48.6 ± 6.65	773.8 (27.78)	88.38 (71.08)
Tenth week	36.0 ± 9.20	649.2 (25.44)	72.88 (59.14)
Twelfth week	24.4 ± 3.49	511.4 (22.57)	55.29 (48.13)
Fifteenth week	16.8 ± 4.06	220.6 (14.70)	33.21 (34.90)
Control	58 .0 ± 11.57	887.8 (29.74)	82.31 (66.39)
SEM ±	4.37	0.92	3.18
C.D. at 5%	12.99	(2.73)	9.46

Figures in parentheses are square-root (fecundity) and angular (egg hatchability) transformed values

Table 2. Influence of adult food supplements on some biological attributes of *M. astur*

Adult food Supplements	Biological Attributes						
	Pre-oviposition Period (Days)	Oviposition Period (Days)	Post oviposition Period (Days)	Fecundity (Eggs/ female)	Hatchability (%)	Longevity (Days)	
						Male	Female
PPGF + Honey (20%)	4.35	40.50	5.14	668.00	89.28 (71.04)	37.07	50.00
PPGF + water	4.78	33.85	4.14	346.85	84.28 (66.78)	31.21	42.92
C.P + Honey (20%)	4.92	35.92	4.85	292.14	90.14 (71.82)	32.78	45.71
Honey (20%)	5.57	14.85	26.92	60.71	92 (73.76)	29.35	47.50
SEM±	0.20	0.54	0.35	25.86	1.08	0.68	0.55
CD at 5%	0.59	1.57	1.02	75.04	2.85	1.99	1.60

PPGF: Power Packed Green Lacewing Food, Values in parentheses are arcsine transformed

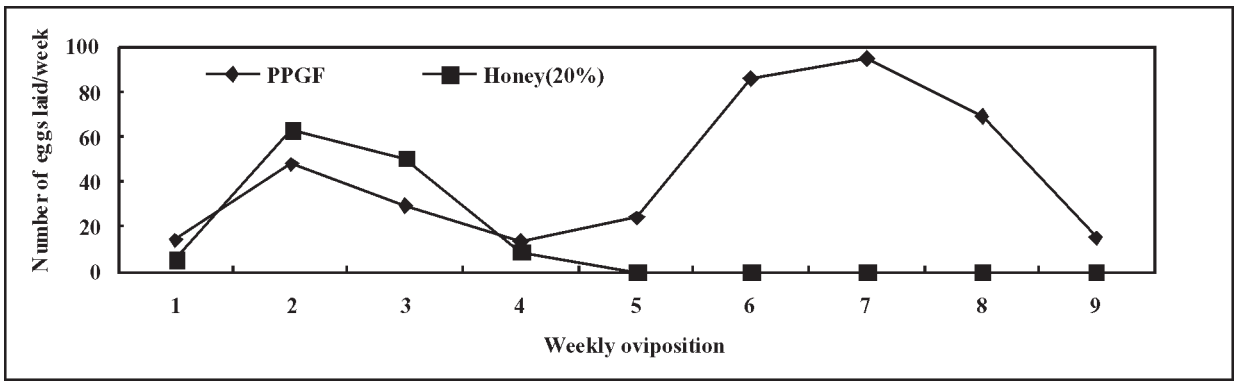

Fig. 1. Influence of PPGF on weekly egg laying pattern of *M. desjardinsi*

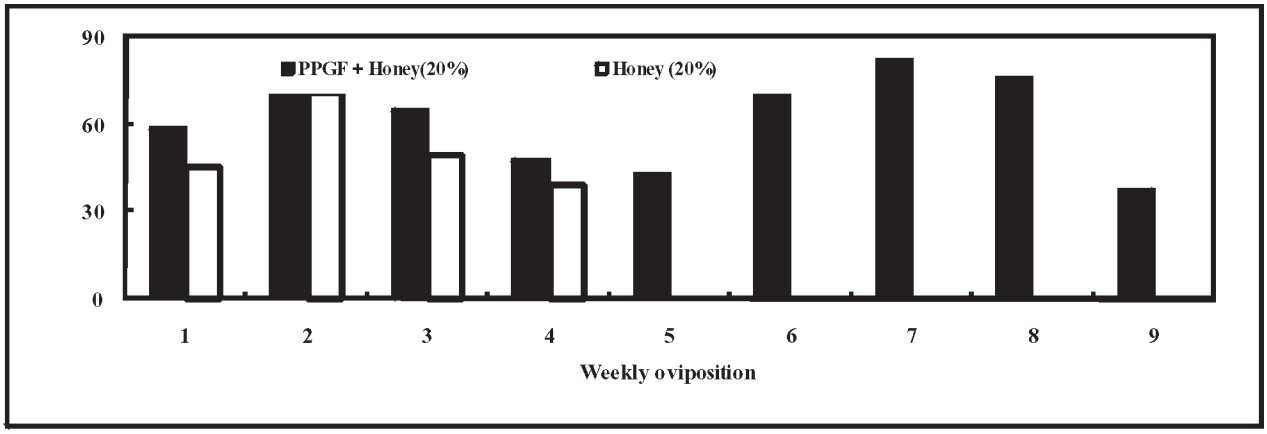

Fig. 2. Influence of PPGF on weekly hatchability pattern of *M. desjardinsi*

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